"THE PROSPECTIVE OBSERVATIONAL STUDY TO EVALUATE THE ROLE OF THE UTERINE ARTERY DOPPLER VELOCIMETRY INDICES FOR THIRD TRIMESTER FETAL SURVEILLANCE IN PREDICTING THE ADVERSE PERINATAL OUTCOMES"

Dissertation submitted to

THE TAMIL NADU DR. MGR UNIVERSITY, CHENNAI

In partial fulfillment of the regulations

For the award of the degree of

M.S. OBSTETRICS AND GYNAECOLOGY

BRANCH - II

MADRAS MEDICAL COLLEGE

CHENNAI

APRIL 2016

DECLARATION BY THE CANDIDATE

I solemnly declare that this dissertation entitled **"The prospective observational study to evaluate the role of uterine artery doppler velocimetry indices for third trimester fetal surveillance in predicting adverse perinatal outcomes"** is a bonafide and genuine research carried outby me at The Institute of Social Obstetrics, Govt Kasturba Gandhi Hospital, Madras Medical College, Chennai, during the year 2014-2015 under the guidance and supervision of Prof.Dr.M.PADMINI,MD. DGO. This dissertation is submitted to the Tamil Nadu Dr.M.G.R. Medical University towards the partial fulfillment of requirements for the award of M.S. Degree in Obstetrics and Gynaecology, Branch - II.

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CERTIFICATE

This is to certify that the dissertation entitled **"The prospective observational study to evaluate the role of uterine artery doppler velocimetry indices for third trimester fetal surveillance in predicting the adverse perinatal outcomes"** submitted by **DR.NASRIN.A** in the **Institute of Social Obstetrics, Govt Kasturba Gandhi Hospital (Madras Medical College) Triplicane, Chennai-5,** in partial fulfillment of the university rules and regulations for award of MS degree in Obstetrics and Gynaecology, Branch - II under my guidance and supervision during the academic years 2014-2015.

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ENDORSEMENT BY THE HOD, PRINCIPAL/ HEAD OF THE INSTITUTION

This is to certify that this dissertation titled **"The prospective observational study to evaluate the role of uterine artery doppler velocimetry indices for third trimester fetal surveillance in predicting the adverse perinatal outcomes"** a bonafide research work done by Dr.NASRIN. A., a postgraduate MS O&G student in the Department of Obstetrics and Gynaecology, Institute of social obstetrics & Govt Kasturba Gandhi Hospital, (Madras Medical College) Chennai-5, under the guidance of prof.Dr.M.Padmini.,MD,D.G.O Professor, Department of Obtetrics and Gynaecology, Institute of Social Obstetrics & Govt. Kasturbai Gandhi Hospital, Madras Medical College, Chennai-5.

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Dear Dr.Nasrin.A.

The Institutional Ethics Committee has considered your request and approved your study titled **"THE PROSPECTIVE OBSERVATIONAL STUDY TO EVALUATE THE ROLE OF UTERINE ARTERY DOPPLER VELOCIMETRY INDICES FOR THIRD TRIMESTER FETAL SURVEILLANCE IN PREDICTING ADVERSE PERINATAL OUTCOMES "** NO.28022015.

The following members of Ethics Committee were present in the meeting held on 03.02.2015 conducted at Madras Medical College, Chennai 3.

1. Dr.C.Rajendran, MD	:Chairperson
2. Dr.R.Vimala,MD.,Dean,MMC,Ch-3	: Deputy Chairperson
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7. Dr..Saraswathy,MD.,Director,Pathology, MMC	: Member
8. Dr.Md.Ali, MD., DM.,Prof.&HOD of Medl.GE,MD.MMC	: Member
9. Dr.S.G.Sivachidambaram,Director I/c, Inst.of Internal Medicine	: Member
10. Thiru S.Rameshkumar	: Lay Person
11.Thiru S.Govindasamy, BA., BL.,	: Lawyer
12.Tmt.Arnold Saulina, MA., MSW.,	: Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Sys 2

Member Secretary – Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
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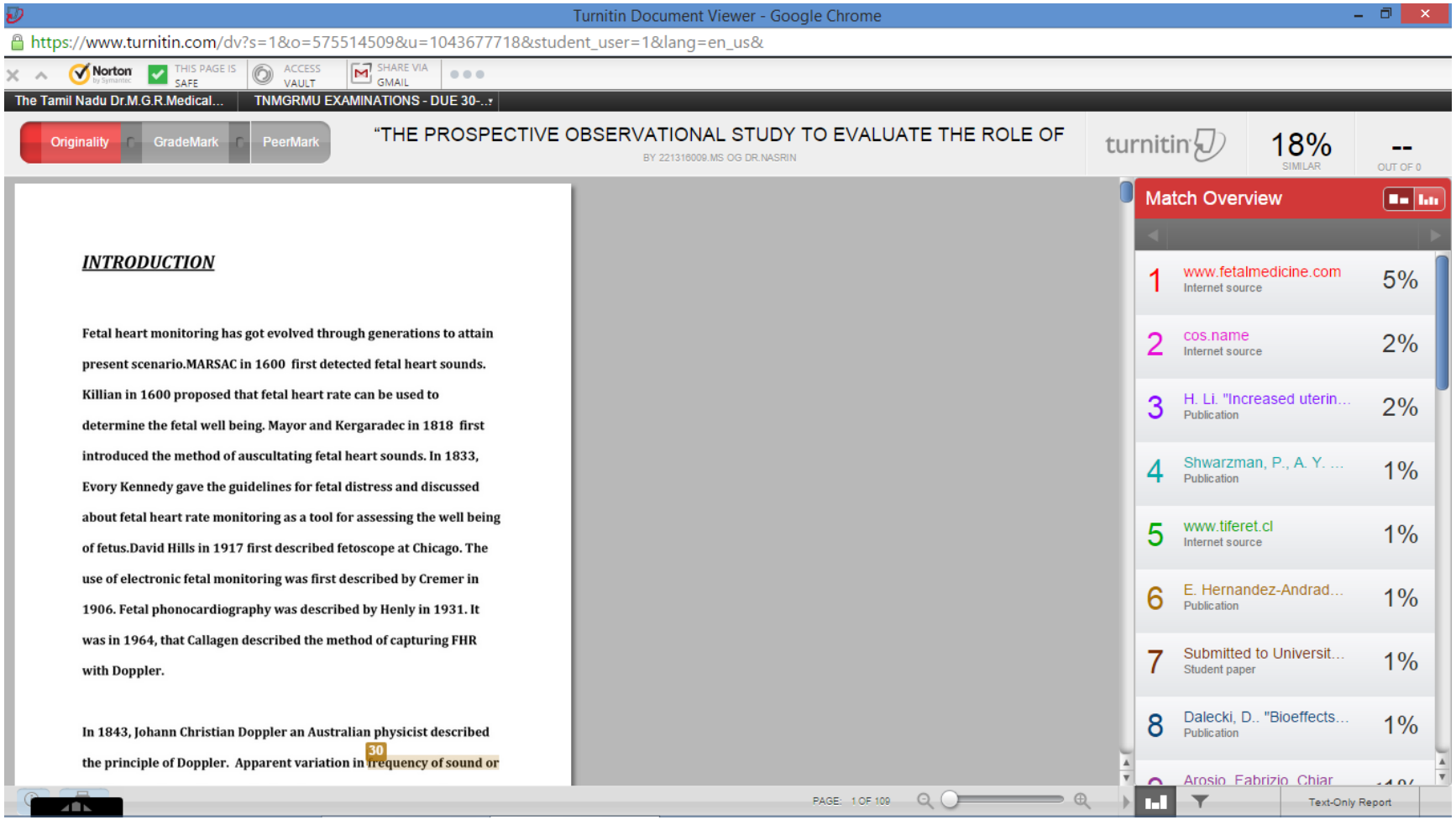
PLAGIARISM ORIGINALITY CERTIFICATE



CONTENTS

LIST OF TABLES

LIST OF FIGURES

“THE PROSPECTIVE OBSERVATIONAL STUDY TO EVALUATE THE ROLE OF THE UTERINE ARTERY DOPPLER VELOCIMETRY INDICES FOR THIRD TRIMESTER FETAL SURVEILLANCE IN PREDICTING THE ADVERSE PERINATAL OUTCOMES”

BACKGROUND & OBJECTIVES:

To study the association between abnormal uterine artery doppler parameters in the third trimester and adverse perinatal outcomes in high risk as well as low risk pregnancies.

- To estimate prognostic value of uterine artery score in predicting and preventing adverse perinatal outcomes.
- To study the importance of fetal middle cerebral artery / uterine artery pulsatility index ratio in prediction of preterm labour
- To understand the importance of including the uterine artery doppler velocimetry along with umbilical and middle cerebral artery dopplers in third trimester fetal surveillance to get optimal perinatal outcomes.
- To compare the predictive values of uterine artery scores, blood flow classes and placental score.

MATERIALS & METHODS

This study was carried out in patients attending the antenatal outpatient department at The Institute of Social Obstetrics, Government Kasturba Gandhi Hospital, Madras Medical College, Chennai during the

academic year 2014-2015. The study was done in 120 patients including the 60 high risk patients and the 60 low risk patients.

- Group A is a high risk group which is comprised of singleton pregnancies beyond 27 weeks with risk factors like Pre ecclampsia, Small for gestational age, Previous bad obstetric history with recurrent fetal losses and perinatal deaths, Chronic hypentension, Diabetes mellitus, Post-dated pregnancy, Preterm labour and autoimmune diseases.
- Group b low risk patients who are singleton pregnancies beyond 27 weeks of gestation without any documented risk factors, to serve as control**.**
- Doppler parameters will be recorded from the uterine artery.
- Blood flow classes based on umbilical artery PI, middle cerebral artery/uterine artery pulsatility index ratio, middle cerebral/umbilical ratio, uterine artery scores and the placental score are recorded.
- The patients enrolled in the study will be followed up till delivery of the baby. Serial doppler evaluations will be done in the study population depending on the expected level of complications. The doppler parameters which are recorded during the study preceding the delivery will be considered for the statistical analysis.

- The mode of delivery, operative delivery for the fetal distress, the gestational age at the delivery, the birth weight, apgar scores at 5 minutes, NICU admissions and perinatal mortality if any will be recorded.

RESULTS:

The mean uterine artery pulsatility index was the single best indicator of adverse perinatal outcomes, with optimal cutoff for ODFD being 1.07. Uterine artery score of 1 had 70.7%sensitivity and 96.7% specificity for operative delivery for fetal distress. All the scores related to uterine and umbilical artery are more in high risk group, reflecting elevated impedance in the uteroplacental circulation.

CONCLUSION:

The current study found that uterine artery doppler indices may be included along with umbilical and middle cerebral artery doppler indices to improve fetal surveillance .It helps to predict adverse perinatal outcomes, optimises monitoring and in preventing complications. Scoring system comprising the doppler indices is better than the independent ratios in the third trimester fetal surveillance.

KEY WORDS:

Uterine artery pulsatility index, operative delivery for fetal distress, uterine artery score, blood flow classes, placental score

INTRODUCTION

An apparent variation in the frequency of the sound or the light wave depending on whether the source moves towards or away from observer is described as the doppler effect. This is similar to the physical phenomenon that as the train approaches or departs the station, there is apparent change in the sound level.This pitch change is directly proportional to shift in frequency of the source[1]

When a certain frequency (fo) insonates a particular blood vessel, reflected frequency (fd) called the frequency shift is directly proportional to the velocity with which blood moves inside the vessel.It is represented as a time-dependent plot on a graph. The frequency shift is represented in the vertical axis and the temporal change of frequency shift in relation to events of cardiac cycle is represented in the horizontal axis.

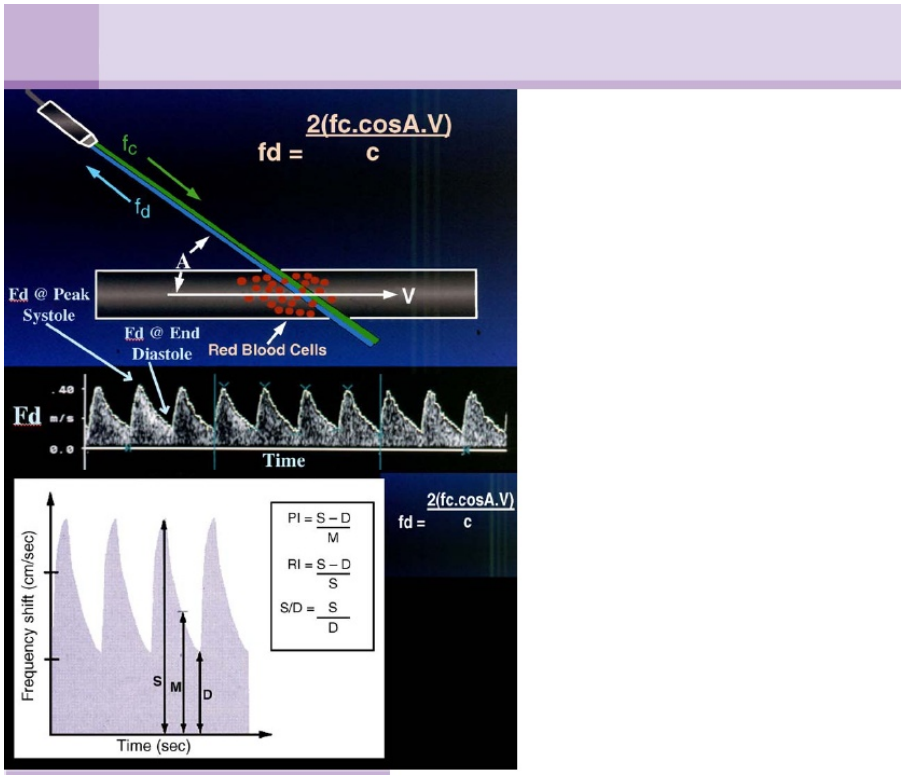


Fig. 1. The Doppler effect

The velocity of blood flow in a blood vessel is inversely proportional to the impedence in the distal vascular bed. The frequency shift is highest during systole and lowest during the end-diastole.

As the insonating angle is difficult to calculate in clinical applications, the indices which depend on the ratio of frequency shifts are used to quantitate doppler waveforms.

The doppler indices which are commonly used [4]

- Systolic diastolic ratio
- Pulsatility index (PI) (Gosling et al)

- Resistance index (RI) which is also called as resistive index or Pourcelot index.

When compared to the resistance index and the systolic diastolic ratio, longer time is needed for the pulsatility index to be calculated because it needs measurement of the mean height of the waveform. The pulsatility index can provide a range of waveforms when there is absent or reversal of end diastolic flow[2].

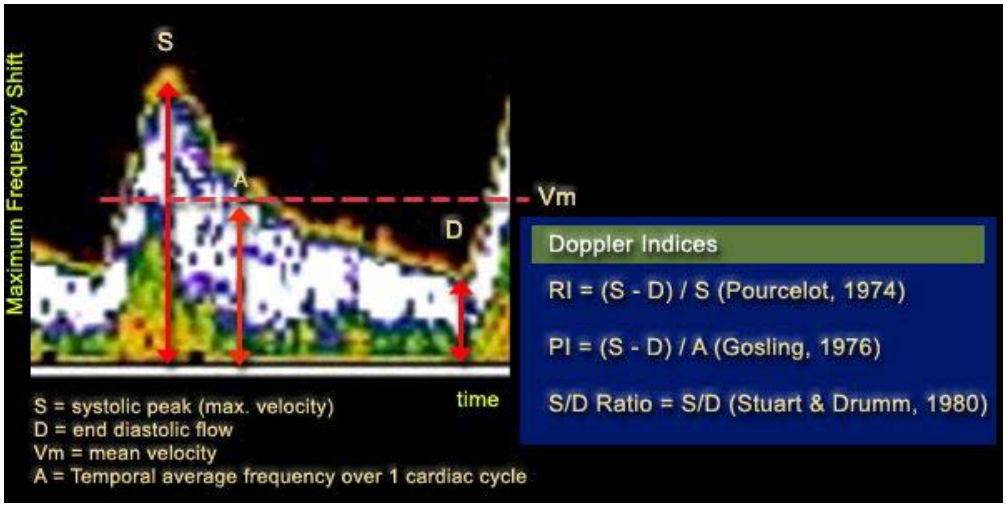


Figure 2. Flow velocity indices

In addition to the doppler indices, the flow pattern can be categorised by the presence or absence of particular features like absence of end diastolic flow and presence of postsystolic notch.

Impaired placentation is screened with uterine artery Doppler for subsequent risk of development of preeclampsia and fetal growth restriction. It helps to understand better the pathophysiology of complicated

pregnancies and help in their clinical management. The responses to impaired fetal oxygenation and hemodynamic alterations are better picked by the color doppler.

The uterine artery doppler has been utilised largely in the first and the second trimesters to screen high risk pregnancies in relation to the development of subsequent complications. There are many studies reported regarding the third trimester doppler changes in uterine artery, but it is not widely used in clinical applications.

Also, the umbilical artery doppler and the middle cerebral artery doppler studies have proved a great way in surveillance of compromised fetuses. Recent studies indicate that the uterine artery doppler velocimetry in third trimester can predict adverse perinatal outcome better than the umbilical artery doppler velocimetry. Hence it should be included as an integral part of fetal surveillance during the third trimester.

The uterine artery and the umbilical artery doppler play a crucial role in identifying potential complications in complicated pregnancies. Pregancies which are complicated by diseases like chronic hypertension, systemic lupus erythematosus, antiphospholipid syndrome and patients with bad obstetric histories are monitored with doppler of the maternal and fetal vessels. Doppler study also helps to study the circulatory changes to predict perinatal death in the post-term pregnancies.

The relationship between the maternal glycemic status in type 2 diabetes mellitus and the uterine artery doppler changes has proved that doppler has a potential role in predicting complications in such pregnancies. The doppler indices get modified if the patient is prone for preterm labour and hence this can be utilised clinically to predict preterm labour . It also helps us to identify the potential time period during which antenatal steroids and tocolysis can be administered.

Recently, the trend is to combine multiple modalities of fetal surveillance like sonography, biophysical profile, non stress test, vibroacoustic stimulation, fetal scalp stimulation, Doppler etc. to monitor the fetuses.

A doppler of multiple vessels is said to be more useful than a single vessel study. The uterine artery doppler is complimentary to the umbilical artery doppler study in the fetal surveillance and vice versa.

Multivessel doppler identifies the fetal compromise weeks ahead, before the changes in amniotic fluid index and biophysical parameter occur. Hence, it is essential to identify the high risk pregnancies and fetuses so that we can decide about the frequency of antenatal testing, planning the time of induction and mode of delivery and thereby the perinatal morbidity and mortality can be brought down.

AIMS AND OBJECTIVES

The elevated uterine artery vascular impedance in the mid-gestation period is strongly related to various complications in advanced gestation. The aim of the present study is to evaluate the importance of including the uterine artery doppler study in the third trimester along with the umbilical artery and middle cerebral artery doppler for fetal surveillance.[51] When abnormal doppler indices are present in high risk pregnancies, it indicates probability of worse pregnancy outcomes. Hence it gives us the opportunity to device strategies to reduce adverse perinatal complications such patients.

The aim of the present study is to evaluate the importance of the uterine artery doppler in the third trimester under the following aspects:

- To study the association between abnormal uterine artery doppler parameters in the third trimester and adverse perinatal outcomes in the high risk as well as the low risk pregnancies.
- To estimate prognostic value of the uterine artery score in predicting and preventing the adverse perinatal outcomes.
- To study the importance of fetal middle cerebral artery / uterine artery pulsatility index ratio in prediction of preterm labour

- To understand the importance of including the uterine artery doppler velocimetry along with umbilical and middle cerebral artery dopplers in third trimester fetal surveillance to get optimal perinatal outcomes.
- To compare the the predictive values of uterine artery scores, blood flow classes and placental scores.

REVIEW OF LITERATURE

HISTORICAL PERSPECTIVES OF FETAL SURVEILLANCE:

Fetal heart monitoring has evolved through generations to attain present scenario. Marsac in 1600 first detected fetal heart sounds. Killian in 1600 proposed that fetal heart rate can be used to determine the fetal well being. Mayor and Kergaradec in 1818 first introduced the method of auscultating fetal heart sounds. In 1833, Evory Kennedy gave the guidelines for fetal distress and discussed about fetal heart rate monitoring as a tool for assessing the well being of fetus.David Hills in 1917 first described fetoscope at Chicago. The use of electronic fetal monitoring was first described by Cremer in 1906. Fetal phonocardiography was described by Henly in 1931. It was in 1964, that Callagen described the method of capturing fetal heart rate with doppler.

In 1843, Johann Christian Doppler, an australian physicist described the principle of Doppler.

BASIC PRINCIPLES OF THE DOPPLER STUDY

The Color flow and the spectral doppler obtain information from the measurements of movement.Series of pulses are generated to measure the movement of blood within the vessel. The echo signals from the stationary

tissue do not vary from pulse to pulse, whereas from moving tissue,it changes from moment to moment

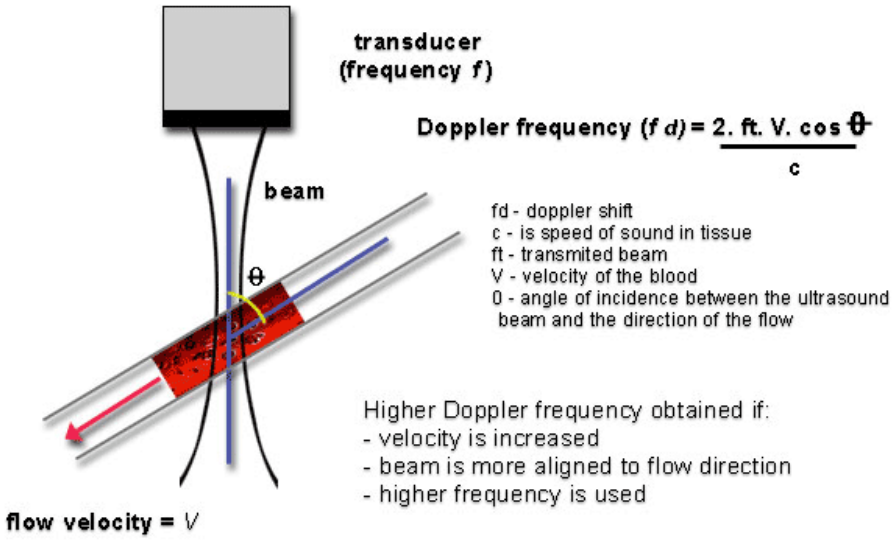


Figure 3. Calculation of Doppler Frequency

Doppler frequency is measured from the phase shift and the size and pattern of the doppler signal depends on factors like blood velocity, ultrasound frequency and the angle of insonation.

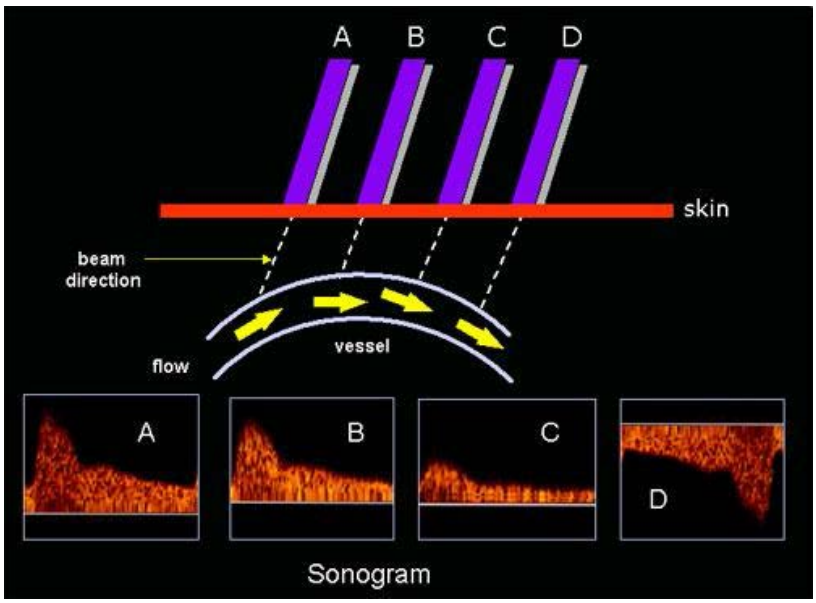
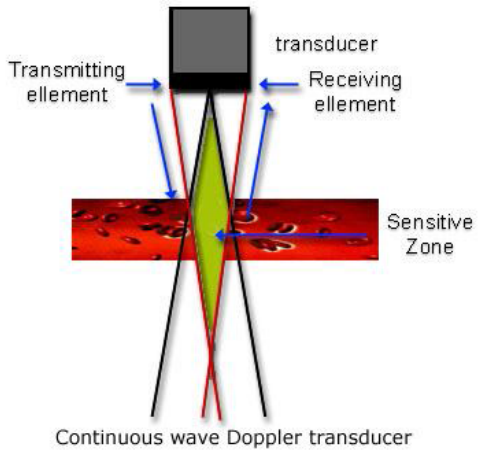


Figure 4. Demonstration of the Doppler Angle



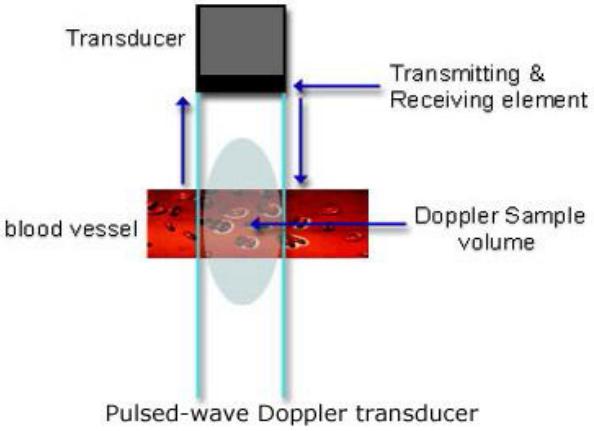


Figure 4a. Continous Wave Doppler Figure 4b. Pulse wave Doppler

The continuous wave doppler uses the continuous transmission as well as the reception of ultrasound. All vessels in path of thedoppler beam are studied. However it is not able to identify the specific location of velocities.

The pulsed wave ultrasound is commonly used in general and obstetric scanners. The depth is measured at flow site and the sample gate can be changed accordingly.

FLOW MODES IN DOPPLER

There are two types of flow modes in doppler. The first type is the colour flow mode and the other one is called as the spectral doppler.

The colour flow imaging provides overall information of a larger region.The spectral doppler gives complete information of a small region being studied. So both the modes are used complimentary to each other. The spectral doppler provides good temporal resolution and helps in calculation of the velocities and indices whereas the colour flow doppler provides colour flow maps and information about the direction.[3]

FACTORS AFFECTING COLOUR FLOW IMAGING

Factors related to color flow imaging include power, gain,frequency selection, velocity scale, pulse repetition frequency, the region of interest and the area of focus.

Other factors like triplex colour, filter, the persistence and processing also affect the colour flow doppler.

The components which are essential in the competent use of the doppler in obstetrics also needs the understanding of:

- The limitations and capabilities of doppler ultrasound.
- Parameters contributing to the flow display.
- Pattern of blood flow in arteries and veins.

DOPPLER STUDY OF THE UTERINE ARTERY

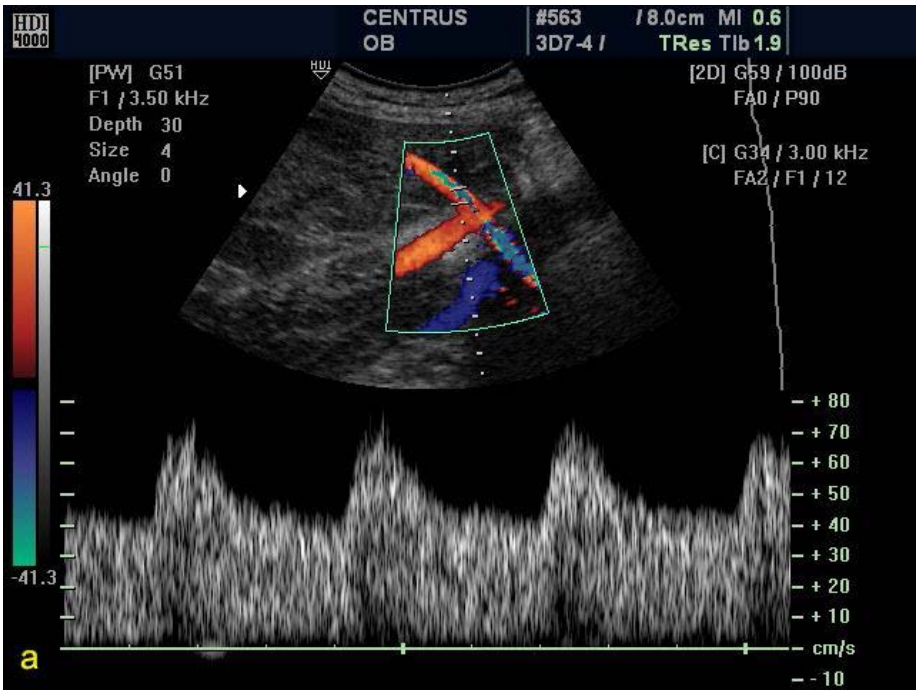


Figure 5. Doppler imaging of the uterine artery. The colour flow helps in the visualisation of the flow angle/beam. This waveform indicates low resistance in the distal vascular bed.

THE SAFETY OF DOPPLER IN FETUS [5]:

The ultrasound doppler is widely considered by users and patients as a safe technique. The possible adverse effects of the doppler ultrasound have been reported in many studies. The ultrasound is a form of mechanical energy in which the pressure wave is made to pass through the tissues.

- **Thermal effects** – The ultrasound waves are converted into heat depending on the absorption coeeficient of the tissues and the duration on how long the tissue volume is scanned.

- **Cavitation –**At high negative pressres, gas bubbles may be formed which may lead to inertial or non-inertial cavitation.
- Other forms of mechanical effects like stress at interface, low level radiation are also being reported.

OUTPUT REGULATIONS, STANDARDS AND GUIDELINES

The United states FDA (Food and drug administration) trough IEC (international electrotechnical commission) has set the standards for the ultrasound usage in obstetrics.

Various national societies like The American institute of ultrasound in medicine, European federation of societies of ultrasound in medicine and biology, World federation of societies of ultrasound in medicine and biology have developed output display standards which include mechanical and thermal index.[6]

The mechanical index is the maximum value of amplitude of pressure pulse in the study tissue. Maximum value allowed is 1.9

The thermal index is the ratio of the power used to cause temperature raise of 1°C.

The "As Low As Reasonably Achievable" principle also called as ALARA must be employed whenever possible in study of the fetus.

The B-mode ultrasound has lower intensity and power output when compared tothe M-mode, Spectral and Colour flow doppler. The doppler gate should be applied after locating the tissues with the B mode ultrasound.

Doppler Study of the Uterine Artery is Affected by the following Factors:

Positioning of mother

During doppler evaluation, semirecumbent positioning of themother with tilting to the left reduces the risk of caval compression and hypotension.

Heart rate pattern of fetus

Heart rate of thefetus and length of the cardiac cycle have inverse relationship. Hence, the configuration of the doppler waveform is influenced by the fetal heart rate. When there is bradycardia of fetus, diastole of the cardiac cycle is prolonged and there is decline of end diastolic frequency. However, it has minimal clinical significance.

Breathing patterns of fetus

The doppler examinations are conducted only during fetal apnea and in the absence of excessive breathing movements or hiccups because breathing causes changes in the flow velocity.

Viscosity of blood

If the viscosity of blood is increased, it causes reduction in the cardiac output and increase in the peripheral vascular resistance.

Giles et al however reported there is no significant association between the blood viscosity and the blood flow impedence

Anatomy of uteroplacental circulation[7]

The uterus is supplied primarily from the uterine arteries along with the collaterals from ovarian artery. The uterine artery and the ovarian artery anastomose at the uterine cornua and give rise to arcuate arteries. The arcuate arteries run circumferentially around the uterus and give rise to radial arteries. The radial arteries penetrate into the outer one third of the myometrial layer of theuterus and give rise to basal and spiral arteries. These vessels provide nourishment to the myometrium, decidua and the placental intervillous spaces. Although there are about 100 functional openings of spiral arteries in a mature placenta,maternal blood enters through only few of these openings.

Physiology ofthe uteroplacental circulation in pregnancy[8]

The remodelling of spiral arteries permits upto ten fold increase in blood flow to the uterus in order to meet nutritional requirements of the placenta and the fetus.

Brosens et al reported a study of the placental bed biopsies to demonstrate the conversion of spiral arteries into uteroplacental arteries which is termed as the physiological change .

This physiological change occurs in two stages:

The first wave of trophoblastic invasion involving the decidual segments occurs during first trimester. The second wave of invasion which occurs during second trimester involves the myometrial segments. This physiological change increases the diameter of spiral arteries from 15 mm to 500 mm. This process reduces the impedence to blood flow thus facilitating optimal fetomaternal exchange.

Invasive assessment of blood flow of uterus

Assali et al placed electromagnetic flowmeters in the uterine vessels to measure the blood flow to uterus. They demonstrated that the uterine blood flow and the consumption of oxygen increases as the gestational period increases[8].

Browne and Veall used Geiger counter after injecting 24 sodium tracer intothe choriodecidual space. They constructed decay curves based on radioactivity and they established the amount of uterine blood flow at term to be around 600 ml/min[9].

Methods to study doppler waveform

Campbell et al obtained doppler waveforms from arcuate uteries withthe use of the pulse wave doppler which is clearly distinct from the iliac vessels.[10]

Trudinger et al obtained the doppler waveforms from branches of the uterine artery with use of the continuous wave doppler.[11]

Schulman et al directed the continuous wave doppler probe into the parauterine region in the lower segment of the uterus and rotated the probe till the characteristic waveforms are obtained. They reported that the early diastolic notch which is present during the study disappeared between twenty to twenty six weeks of pregnancy.[12]

Bewley et al used the continuous wave doppler at four fixed points on the uterus to obtainthe flow velocity waveforms. The lower two points were insonated in a similar way by Schulman et al. The transducer was kept 2 cm above the inguinal ligament on either side of the uterus. The upper two points were midway between the fundus of the uterus and themost lateral point on the uterus[13].

Arduini et al did a comparative study between the color flow doppler and the pulse wave doppler to study the uterine artery. The main uterine artery was visualised medial to the external iliac artery with the colour flow

doppler. The doppler gate was chosen at the point ofthe maximal brightness. The mean value of the multiple readings was taken for the calculation to reduce the inter and intra observer variations of co-efficients of variation[14].

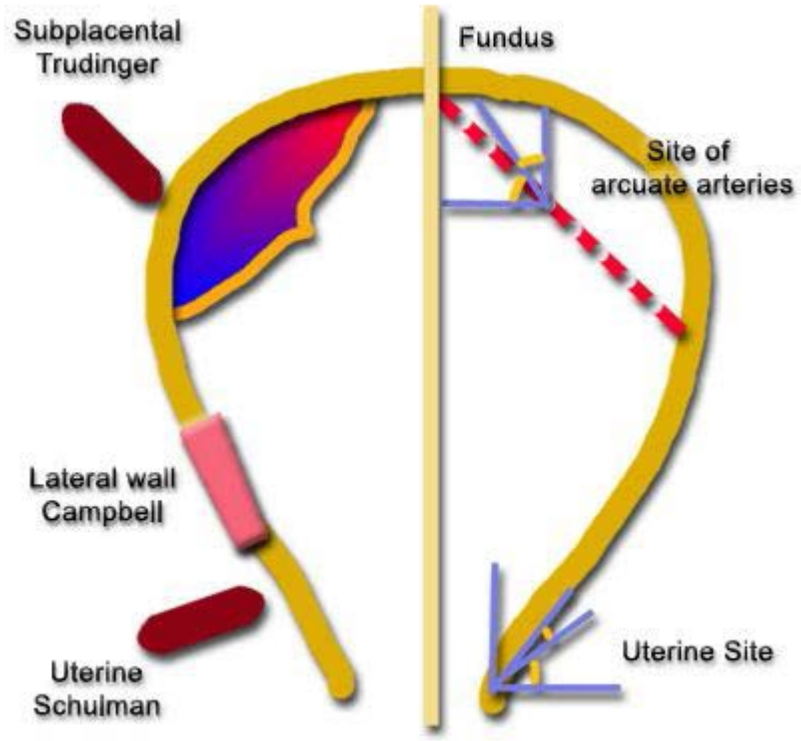


Figure 6. Bewly et al Model of the Study of Insonation of the Uterine Artery[13]

The uterine artery blood flow impedence progressively falls as the gestation advances. The hormonal changes in pregnancy increase the elasticity of arterial walls. With the trophoblastic invasion of spiral arteries taking place primarily on the placental side, the impedence to the uterine

blood flow on the placental side is lower than the non placental side of the uterus. The fall in impedence of the uterine blood flow on the non placental side is facilitated by the development of collateral blood vessels.

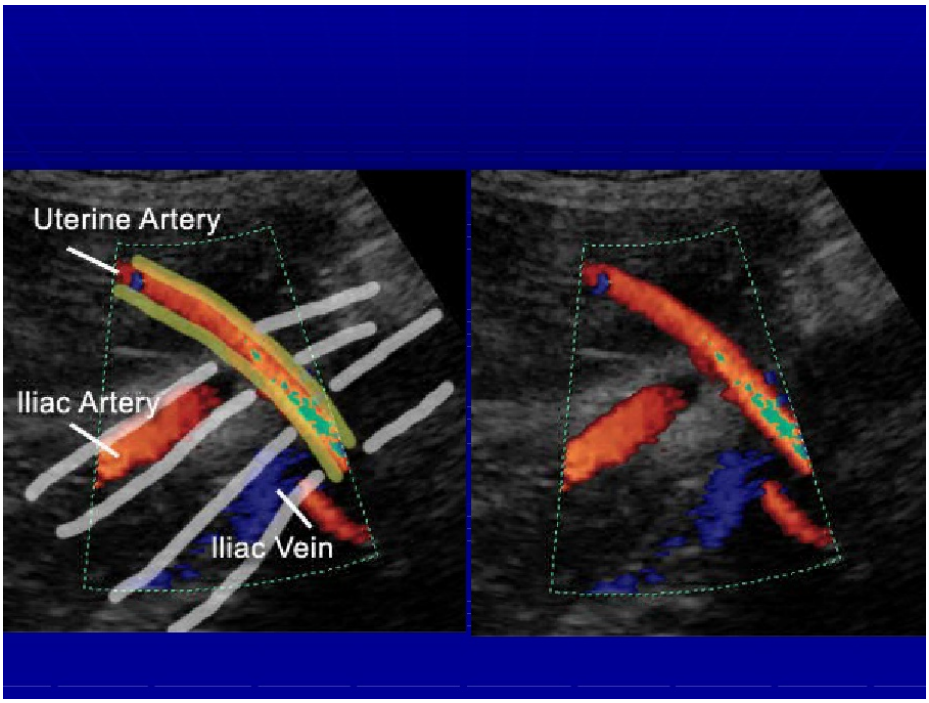
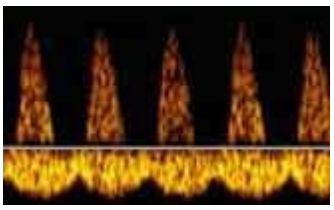


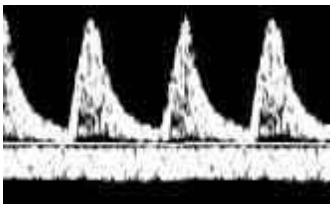
Figure 7. The Site of the Doppler Study of the Uterine Artery is just Cranial to the Crossing of the External Iliac Artery[15]

The Uterine Artery is gated just proximal to the anatomical crossing of the external iliac artery, taking the inquinal ligament as the landmark.

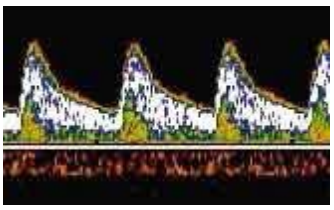
Figure 8. Uterine artery waveforms



Normal flow pattern in the first trimester.

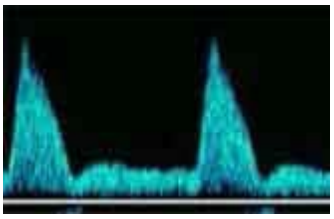


Normal flow pattern inthe second trimester.

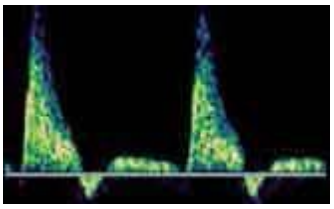


Normal waveform pattern of the uterine artery during the late second trimester and during the third trimester.

Abnormal waveform patterns of the uterine artery



Elevated impedance to the uterine artery blood flow with the characteristic early diastolic notching.



Elevated impedence in the uterine artery blood flow with the reversed diastolic flow.

Uterine Artery Pulsatility Index

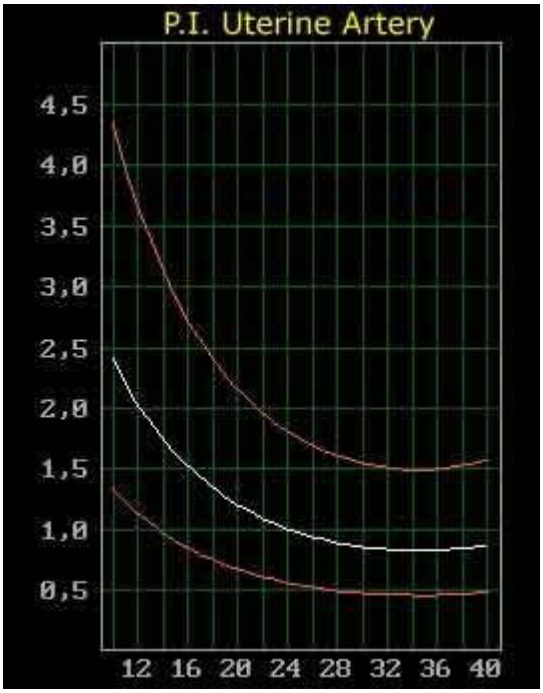


Figure 9. The Longitudinal Reference Range Curve for the Uterine Artery with the mean, the 5th and 95th Percentiles

Adequate placental perfusion is maintained by the low resistance in the uterine arteries for the fetal well being. The increased resistance and impedence especially in the cases of pregnancies which are complicated by preeclampsia and fetal growth restriction is studied with the uterine artery doppler velocimetry indices. This method of doppler surveillance helps in the prediction and prevention of adverse pregnancy outcomes.[16]

UTERINE ARTERY DOPPLER IN EARLY GESTATION:[63]

Zemen et al has demonstrated that changes occur in maternal circulation as early asthe first trimester in women who develope preeclampsia and fetal growth restriction.

Cristiane barbieri conducted in 2004, a systematic review of doppler studies of theuterine artery flow in the second trimester to predict fetal growth restrictionand preeclampsia. (Campbell 1986-1993).

The CLASP study (Collabarative low dose Aspirin study) done in 1994 was a large scale study done in 9364 women to study the effectiveness of aspirin prophylaxis in prevention of development of preeclampsia.[64]

THE UTERINE ARTERY DOPPLER IN THIRD TRIMESTER:[54,55,56]

Sekikuza et al developed a scoring system based on the uterine artery waveforms in the third trimester. Higher the scores, worse were the fetal outcomes. The cutoff values of the resistance index was used in their calculation.

Hernandez andrade et al developed a modified scoring system based on the placental location. They compared two types of uterine artery scoring systems. The uniform uterine artery score was calculated not taking the placental position into account and using a cut-off pulsatility index of >1.2 for boththe uterine arteries.

The differentiated scoring system for the uterine artery doppler was calculated based on the placental localisation with a cut-off pulsatility indices >1 for the placental and >1.4 for the nonplacental sides.

The receiver operator characteristic curves for the above study gave the best diagnostic performance to the uterine artery score which had > 2 for both the types of scores. No significant difference was found between the two curves. If the score was high, there was significant risk of adverse perinatal outcomes .

Zimmerman and colleagues et al considered the lowest value of the pulsatility index of the two uterine arteries as the placental value.[28]

North et al and coworkers found that there is significant degree of placental lateralisation in the complicated pregnancies.[63]

Hofstaetter et al described even one abnormal parameter in the uterine artery doppler waveform as a marker of risk. They reported that notching to be better predictor of the perinatal outcome than the elevated pulsatility index.

Ghidini and locatelli et al reported that abnormal uterine artery doppler indices can predict the likelihood of an unfavourable perinatal outcome during the third trimester.

Schulman et al reported that the systolic diastolic ratio falls progressively from the second trimester until term in uncomplicated pregnancies.

UTERINE ARTERY DOPPLER IN HYPERTENSIVE PREGNANCIES[17]

Saxena et al reported that the mean doppler values were high in the hypertensive group when compared to the normal group.

Trudinger et al reported 47.3% of hypertensive cases had abnormal uterine artery doppler.

Park et alevaluated 1090 patients serially from the second trimester till the third trimester.They showed that the positive predictive value of uterine artery doppler was 90% for fetal growth, preeclampsia and preterm delivery in those cases where both a notch and a high systolic diastolic ratio were found.

UTERINE ARTERY DOPPLER AND POSTPARTUM OUTCOMES

De melo et al showed a relationship between the elevated uterine artery doppler wave forms in the third trimester and the development of adverse postpartum outcomes such as prolonged hospitalisation, prolonged use of antihypertensive medications in the postpartum period.

Ghi et al reported that the maternal outcomes were not related to the abnormal doppler findings.

UTERINE ARTERY DOPPLER AND PERINATAL OUTCOMES

Thaker et al reported an increased rate of operative delivery for fetal distress, NICU admission rates, and abnormal fetal heart rate tracing in the labouring women who had elevated impedence in the uterine artery compared to those with the normal circulation.

UTERINE ARTERY DOPPLER IN LOW RISK PREGNANCIES

Cooley et al found abnormal uterine artery doppler indices predicted the worst perinatal outcomes even in the low risk populations.[65]

Severi et al included the uterine artery doppler for the fetal surveillance in addition to the umbilical and the middle cerebral arteries. They showed that there is an increased risk of caesarean delivery for fetal distress for these fetuses despite the normal umbilical artery but with abnormal uterine artery doppler.

MULTIVESSEL DOPPLER IN HIGH RISK PREGNANCIES

Joern et al from Germany reported that examining the uterine arteries is essential in the high risk pregnancies to assess the placental performance and the fetal well being. They studied 142 high risk pregnancies complicated by HELLP and compared the perinatal outcome in relation to the doppler of the uterine, umbilical and middle cerebral arteries. An increased vascular impedence in the uterine artery was present in as many

as 95% of the cases. The worst outcomes were seen when all the three vessels were abnormal.

Vergani et al reported that adverse perinatal outcomes occurred more frequently with the abnormal uterine artery doppler compared to the normal uterine artery doppler in 294 fetuses with growth restriction beyond 34 weeks of gestation.

Soregaroli et al performed serialuterine artery doppler screening during the second and the third trimesters. 49% of cases who had an abnormal uterine artery doppler at 24 weeks of gestation became normalised at 34 weeks of gestation. This study suggests that only in those cases who have persistent abnormal uterine flow velocity waveforms till the third trimester have more chance of adverse outcomes.

REFERENCE CURES FOR DOPPLER INDICES

Kofinas et al established the reference values for the uterine artery RI and the systolic/diastolic ratio.[30]

Marsal and Gudmundsson conducted a prospective cross sectional study of patients from 20^{th} to 42^{nd} week of gestation and constructed the reference pulsatility index value range.

Wladimiroff et al constructed the reference range for the pulsatility index ofthe umbilical artery in the third trimester.

Ebbing et al constructed the longitudinal reference range for the cerebroplacental ratio with a cut-off 1.08

Baschat and Gembruch et al reported that the cerebroumbilical or the cerebroplacental ratio has the advantage of identifying the cause of redistribution of blood flow to the brain.

Simanaviciute and Gudmundsson et al compared the accuracy of the middle cerebral/uterine artery pulsatility ratio and the middle cerebral/umbilical pulsatility ratio for the prediction of adverse outcomes. They reported that the predictive value of both the ratios are the same.

Kirkinen et al, Gramellini et al and Chandran et al studied the middle cerebral artery indices in normal and the growth retarded pregnancies and they constructed the reference limits of PI and RI which showed a progressive decline with advancing gestation. However in the growth retarded pregnancies, low PI and RI were associated with an increased perinatal risk.

Palacio et al developed the reference ranges for the umbilical artery and middle cerebral artery pulsatility indices and the cerebroplacental ratio in the post-term pregnancies.

SCORING SYSTEMS BASED ON DOPPLER INDICES[37]

Gudmundsson et al defined the abnormal uterine artery doppler as the uterine artery score more than zero. The uterine artery blood flow

velocity waveforms was classified into five classes of the uterine artery scores (UAS), ranging from 0 to 4 and the adverse outcomes were analysed.

Gudmundsson et al also classified the umbilical artery waveforms into four groups of the blood flow classes(BFC),ranging from 0 to 3.

The uterine artery score and the blood flow classes were combined to form the placental score (PLS) as an expression of the total placental vascular resistance. The placental score has eight classes ranging from 0 to 7, which is the sum of uterine artery score and the blood flow classes.

THE UMBILICAL ARTERY DOPPLER

Fitzerald et al evaluated the umbilical artery doppler velocimetry indices. It is the first fetal vessel to be studied for the fetal well-being. The umbilical cord has two umbilical and one umbilical vein.

There is a characteristic saw-tooth waveform pattern in the umbilical artery and continuous venous blood flow in umbilical vein.[21,22.]

The umbilical cord is sampled at its free floating portion havingthe umbilical artery and umbilical vein.The impedence indices are lower at the placental end than at the fetal end. Closer the sample is tothe placenta, lesser the wave of reflection, greater the diastolic flow and lesser the impedence of the waveform pattern.

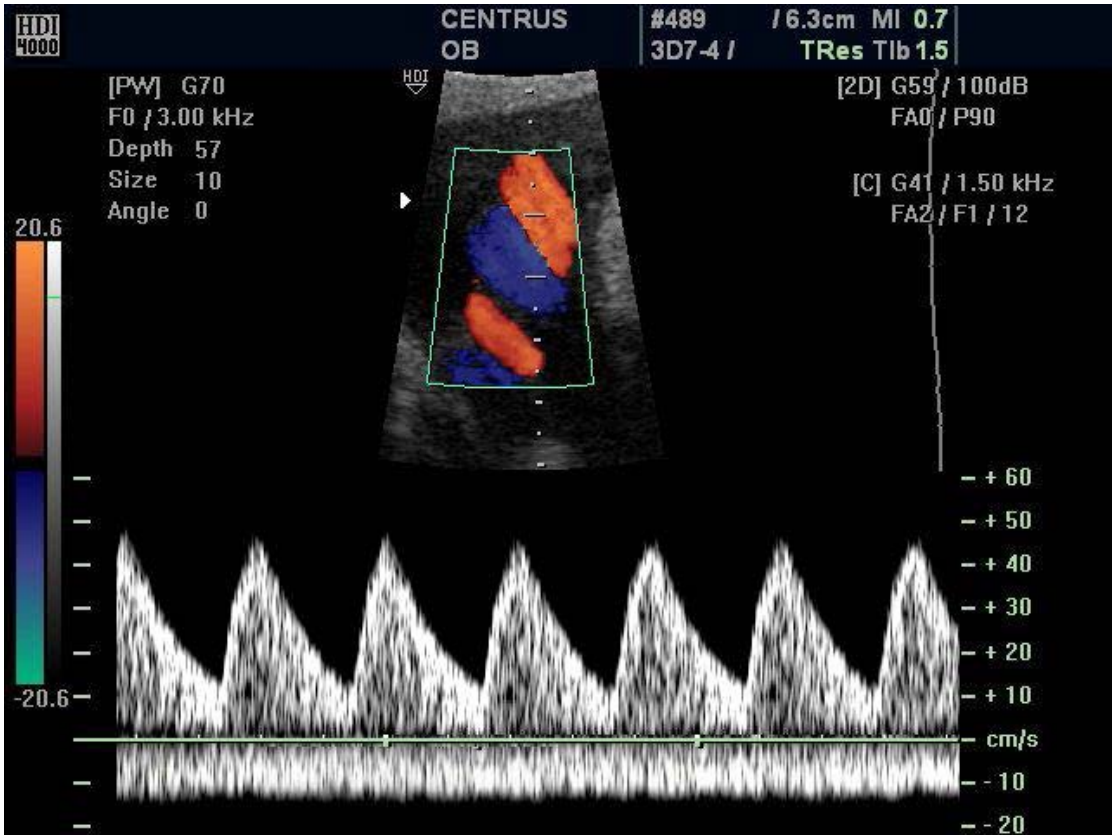


Figure 10. The colour doppler showing the umbilical artery (red) and umbilical vein (blue). Normal waveform pattern of the umbilical artery (above) and normal waveform pattern of the umbilical vein (below).

As the gestational age advances, the umbilical arterial doppler waveforms show a progressive rise in the end-diastolic velocity and decrease in the pulsatility index .

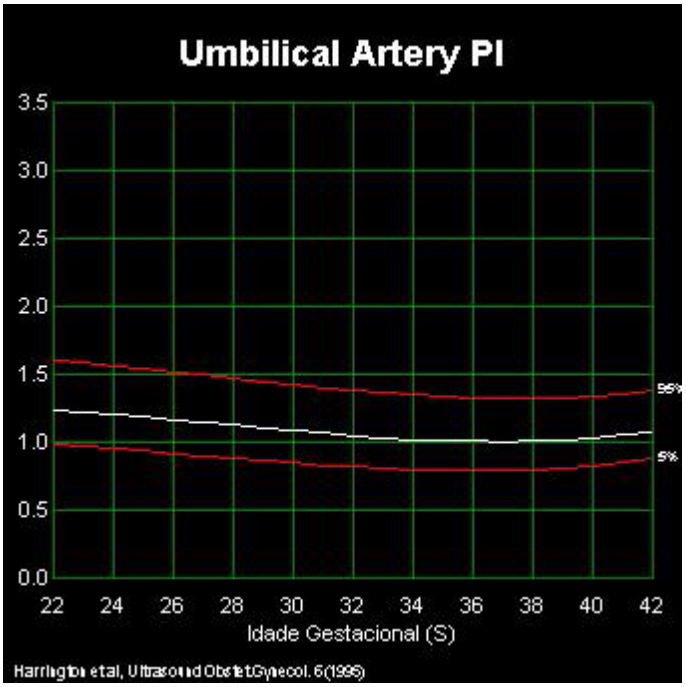
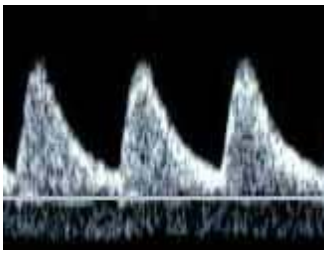
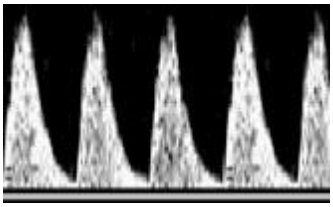


Figure 11. The longitudinal reference range curve for the umbilical artery from 22 to 42 weeks of gestation showing the mean, the 5th and 95th percentile.

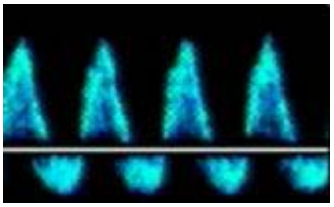
Figure 12. The Umbilical Artery Doppler Waveform Patterns:[61]



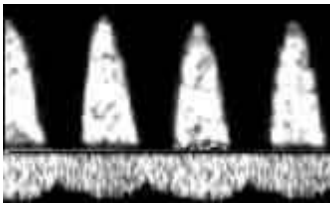
Normal pulsatility index of the umbilical arteries



Elevated pulsatility index of the umbilical arteries.



A severe case showing the reversal of end diastolic frequencies.



Significantly elevated pulsatility index in the umbilical arteries along with pulsation inthe umbilical vein.

THE MIDDLE CEREBRAL ARTERY DOPPLER:[44]

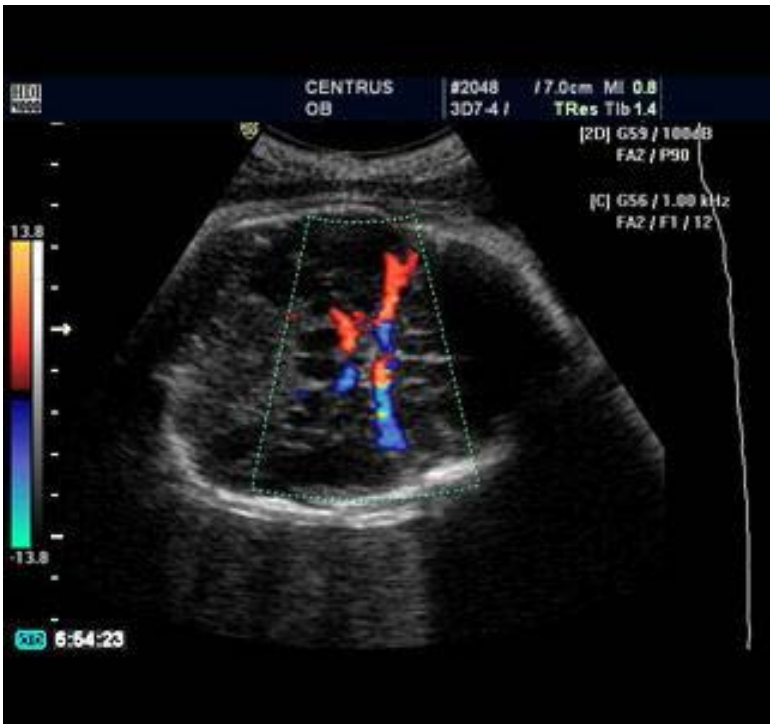


Figure 13. Sampling of the Circle of Willis for the Middle Cerebral Doppler Study

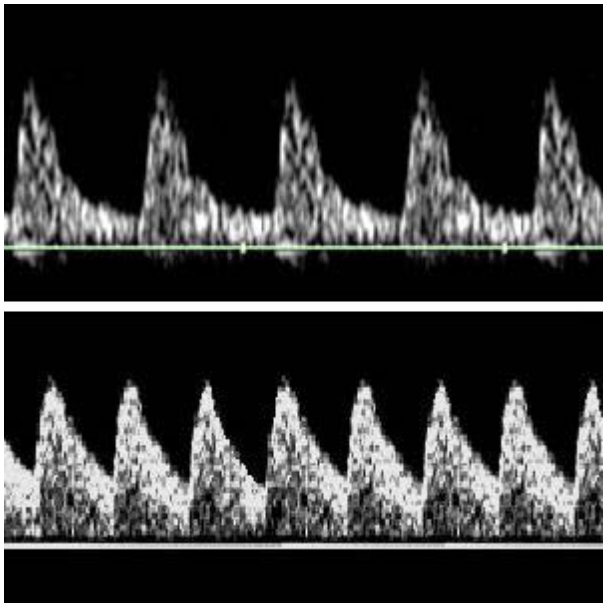


Figure 14. The middle cerebral artery doppler waveforms in a normal fetus with low diastolic velocities (top). In a growth-restricted fetus with elevated diastolic velocity and low pulsatility (bottom).

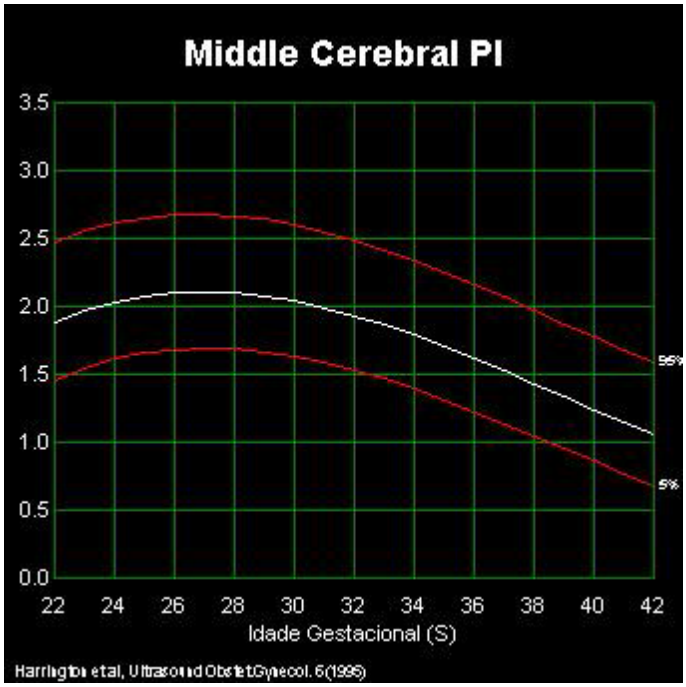


Figure 15. The longitudinal reference range for the middle cerebral artery pulsatility index showing the mean value, the 5th and 95th percentile.

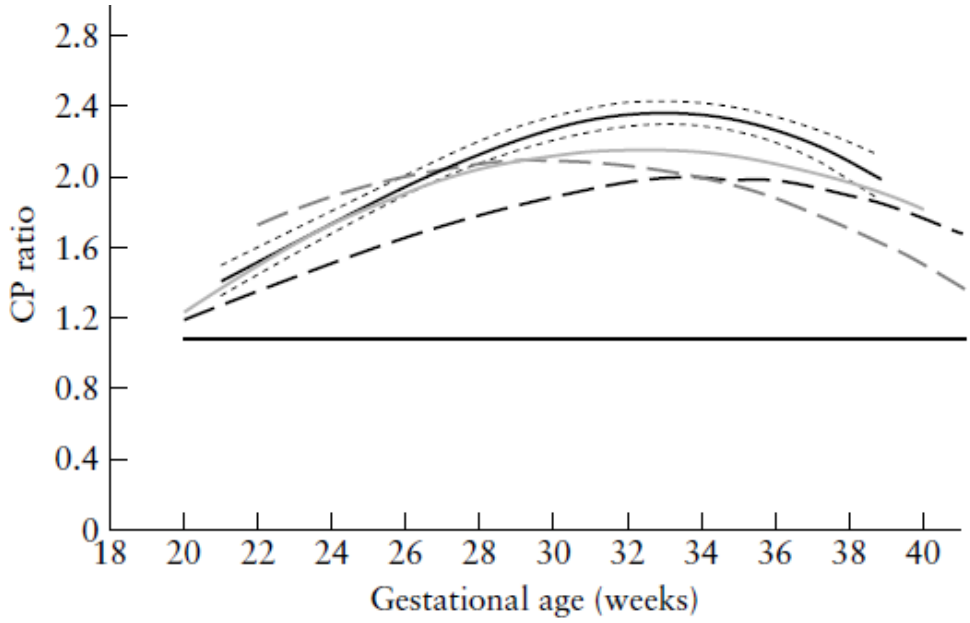


Figure 16: The cerebroplacental ratio reference range with categorical cut-off 1.08 according to Gramellini et al.

Bahado-Singh et al reported that the very low cerebroplacental ratio is associated with the peripheral vascular changes both in the arteries and veins.

The cerebroplacental ratio is commonly used in the clinical practice in the fetal surveillance nowadays.

FETAL VENOUS DOPPLER[17]

A reduced diastolic flow in the umbilical artery indicates the fetal compromise whereas an absent or reduced diastolic flow in the umbilical artery indicates the fetus is severely compromised with an impending intra-uterine death. Such severly compromised fetuses need to be monitored with

the ductus venosus doppler, the umbilical vein pulsations and the inferior vena cava pulsations.

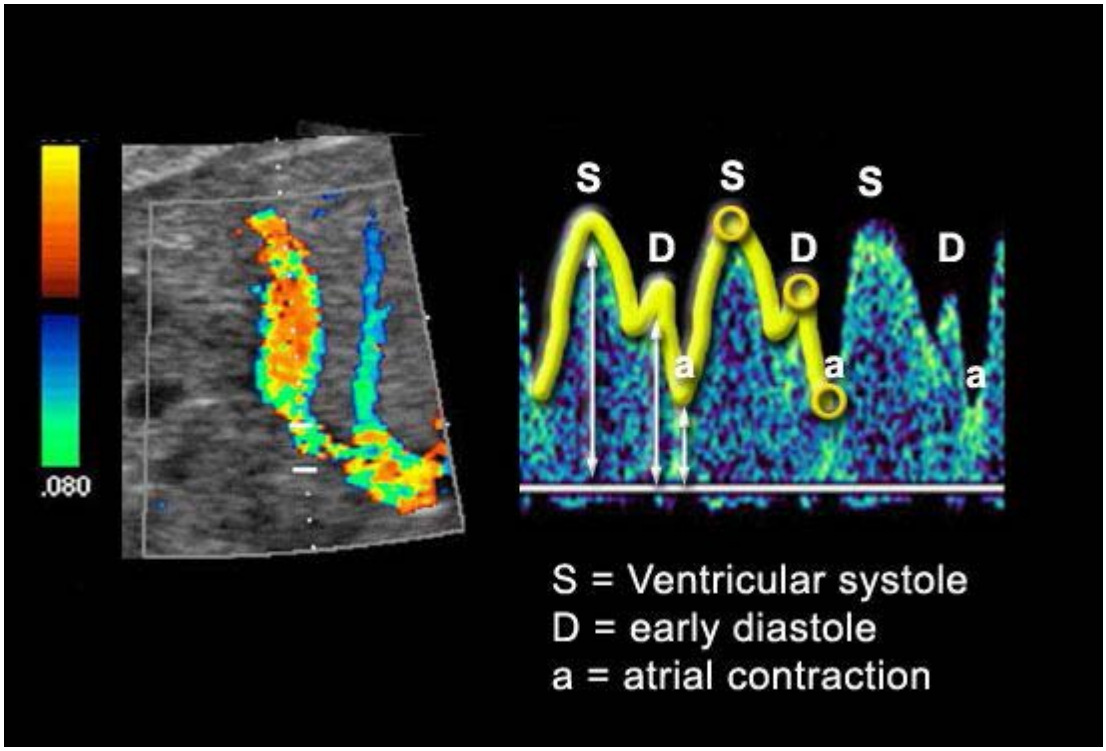


Figure 17. Normal Doppler Waveform Pattern of the Ductus Venosus.

Figure 18. The Pulsatile Pattern the Umbilical Vein in a Severely Compromised Growth-restricted Fetuses[19,20]

DOPPLER WAVEFORM PATTERNS IN THE VARIOUS PREGNANCY COMPLICATIONS:

PRE-ECLAMPSIA AND FETAL GROWTH RESTRICTION[47,48]

The doppler study of the uteroplacental circulation in preeclampsia and fetal growth restriction shows that there is poor quantity and quality of the maternal vascular response to the trophoblastic invasion.

Brosens et al reported there is absence of thenormal physiological changes in the spiral arteries beyond the myometrial-decidual junction in more than 80% of the cases of severe preeclampsia, by doing the placental biopsies.

Robertson et al examined the placental bed biopsies in preeclampsiaand essential hypertension patients. In preeclampsia, there were necrotizing lesionsalong with the foam cells in the wall of the basal and spiral arteries, which was termed as the ‘acute atherosis’. In essential hypertension, the hyperplastic lesions were noted in the basal and spiral arteries.[39]

Studies show thatthe elevated impedance in the umbilical arteries evident only when there is at least 60% of the placental vascular bed is obliterated . There are ‘hemorrhagic endovasculitis’ and abnormally thin-walled fetal stem vessels, growth restricted fetuses with absent or reversed

diastolic flow in the umbilical arteries and elevated impedence in the uterine arteries.[40]

DOPPLER STUDIES IN PREGNANCIES WITH MATERNAL DIABETES MELLITUS :

The doppler study of the umbilical and uterine arteries in the diabetic pregnancies is used for the prediction of the subsequent development of preeclampsia and fetal growth restriction in the same way as that for the nondiabetic pregnancies.[23]

The elevated impedance of the uterine doppler in the pregnancies complicated by type 2 diabetes mellitus proves that there is an increased incidence of stillbirths and neonatal morbidity in such pregnancies. The maternal hyperglycemia may cause vasoconstriction in the placental bed by the impairement of the prostacyclin production.[24]

Haddad et al studied doppler waveforms of theuterine arteries of 37 diabetic pregnancies and reported that there is high impedance in 45% of those who subsequently develope pre-eclampsia and fetal growth restriction.[28]

THE UTERINE ARTERY DOPPLER IN THE PRETERM LABOUR[57]

The elevated uterine artery pulsatility index significantly predicts preterm labour. A high middle cerebral artery/uterine artery ratio has high

sensitivity and specificity to predict the spontaneous onset of the preterm labour.

THE UTERINE ARTERY DOPPLER IN AUTOIMMUNE DISEASES AND CHRONIC HYPERTENSION

In the antiphospholipid syndrome, there is extensive thrombosis of the uteroplacental vasculature resulting in the placental infarction.

This disease is associated withthe early pregnancy losses and subsequent complications like preeclampsia and featl growth restriction. These complications are preceded by elevated impedance in the doppler waveforms of theuterine and umbilical arteries.[29]

Weiner et al carried out serial doppler studies of the uterine and umbilical arteries in patients with pregnancies complicated by systemic lupus erythematosus from the first trimester till term. Their study revealed thatthe umbilical artery indices were above the 95th percentile in all these cases.

Guzman et al reported that in the pregnancies complicated by antiphospholipid antibody syndrome, the worst perinatal outcomes occurred when there was an elevated impedence in the uterine and umbilical arteries.

Trudinger et al however suggested that the infarction of the placental blood vessels might be an acute phenomenon causing sudden deterioration of the fetal condition rather than chronic placental insufficiency .

Arduini et al did a study on women who had essential hypertension or renal disease or preeclampsia in previous pregnancy. There was raised doppler indices in such pregnancies and 64% of such patients subsequently developed gestational hypertension in this pregnancy.[47]

DOPPLER IN POSTTERM PREGNANCIES[60]

Rightmire and Campbell did a study on pregnancies which crossed 42 weeks of gestation[60]. They reported that high impedence in the uterine and umbilical blood flow was associated with the adverse perinatal outcomes.

Anteby et al reported that in the uncomplicated post dated pregnancies, those patients who had abnormal doppler parameters were more prone for intervention following the fetal distress.

MATERIALS AND METHODS

This study was carried out in patients attending the antenatal outpatient department at The Institute of Social Obstetrics, Government Kasturba Gandhi Hospital, Madras Medical College, Chennai during the academic year 2014-2015. The study was done in 120 patients including the60 high risk patients and the 60 low risk patients .

Study Design

Prospective observational study

Ethics

The Institutional ethics committee clearance obtained.

Study population

A prospective study will be done in the randomly selected patients with singleton pregnancies beyond 27 weeks, after obtaining the written informed consent.

Sample Size

High risk 60

Low risk 60

Data collection

Details of demographic and obstetric data will be collected from enrolled patients. The details of the parameters like the age, parity,the body masss index, haemoglobin level, the gestational age at the last doppler

study, systolic and diastolic blood pressure of the mother will be recorded from the patients enrolled in the study after getting the informed consent from the patients.

Inclusion Criteria

Group A- High risk group

Singleton pregnancies beyond 27 weeks (Gestational age assigned by last menstrual period or by ultrasound done in first trimester) with risk factors like

- Pre ecclampsia (mild and severe)
- Small for gestational age (fetal abdominal circumference < 10th percentile)
- Previous bad obstetric history with recurrent fetal losses and perinatal deaths
- Chronic hypentension
- Diabetes mellitus diagnosed before conception or before 20 weeks of pregnancy.
- Post dated pregnancy (> 40 and <42 weeks of pregnancy)
- Preterm labour (regular uterine activity before 37 weeks)
- Autoimmune diseases

Definitions

- Pre-eclampsia is defined as the blood pressure above 140/90 mmHg and proteinuria of more than 1+ urine dipstick on two occasions which are at least 12 hours apart and the patient should be at rest.
- Fetal growth restriction:Fetal abdominal circumference less than the 10th percentile for the corresponding gestational age.
- Preterm labour: Onset of regular uterine contractions before 37 completed weeks.

GROUP B- low risk patients

Singleton pregnancies beyond 27 weeks of gestation (Gestational age assigned by the last menstrual period or by ultrasound done in the first trimester) without any documented risk factors, to serve as control

Exclusion Criteria

- Ultrasound showing the gross fetal anomalies
- patients with the multiple pregnancies
- patients who did not come for the follow up
- patients who plan delivery at other hospitals
- patients in active labour or with major complications presenting as an emergency
- patients with gestational age < 27 weeks
- patients with gestational diabetes mellitus.

Doppler evaluation of the uterine artery

Doppler parameters will be recorded from the uterine artery just proximal to the crossing of external iliac artery.

Parameters will be considered abnormal if

a. The pulsatility index > 95% centile above the mean for the corresponding gestational age.

b. Persistence of the diastolic notch

c. The uterine artery score is more than 0 which is the composite score combining the pulsatility index and the notching of the wave.

Uterine artery score

0 No notching or high pulsatility index in both the uterine arteries.

1 One abnormal parameter, either high pulsatility index or the notching in one of the uterine arteries.

2 Any two abnormal parameters are present.

3 Any three abnormal parameters are present.

4 All the four abnormal parameters are present (bilateral notching and bilateral high pulsatility)

DOPPLER EVALUATION OF THE UMBILICAL AND THE MIDDLE CEREBRAL ARTERY

The umbilical artery blood velocity signal is recorded from the free floating part of the cord and the middle cerebral artery velocity signal is obtained 1 cm distal to the circle of willis with the angle of insonation <20 degrees.

The umbilical artery doppler will be considered abnormal if the pulsatility index is more than two standard deviations above the mean for the gestational age. An absent/reversed end diastolic flow in the umbilical artery is pathological and the patients will be admitted to the hospital for the subsequent monitoring and further management.

Blood flow classes

0 Normal umbilical artery doppler waveforms in both sides.

1 The pulsatility index between +2 and +3 standard deviations above the mean value for the corresponding gestational age.

2 The pulsatility index +3 SD above the mean but there is forward flow during diastole.

3 Absence reversal of end-diastolic flow

The **middle cerebral artery / uterine artery pulsatility index ratio** is considered abnormal if the ratio is less than the 5th percentile value for the corresponding gestational age.

The **middle cerebral/umbilical ratio** is considered abnormal if the value is less than the cut-off value 1.08.

The **blood flow classes** based on the umbilical artery will be calculated with the values ranging from 0 to 3. The placental score which is the sum of the uterine artery score and the blood flow classes will be calculated with values ranging from 0 to 7.

FOLLOW UP OF THE PATIENTS

The patients enrolled in the study will be followed up till delivery of the baby.Serial doppler evaluations will be done in the study population depending on the expected level of complications. The doppler parameters which are recorded during the study preceding the delivery will be considered for the statistical analysis.

PERINATAL OUTCOME ASSESEMENT

Parameters assessed:

The mode of delivery, operative delivery for the fetal distress, the gestational age at the delivery, the birth weight, apgar scores at 5 minutes, NICU admissions and perinatal mortality if any will berecorded.

Statistical analysis

Statistical analysis of the study is performed with the SPSS software. The chi square tests, student t test, independent t tests will be used. Multiple logistic regression and linear regression models will be used to find out the confounders. Spearman correlation test to find out the parametric variables. P values less than 0.05 will be considered significant

RESULTS

Total number of patients in the high risk group:60

Total number of patients in the low risk group:60

TABLE 1:AGE OF PATIENT

Age Group (Years)	HIGH RISK GROUP	%	LOW RISK GROUP	%
17-20 yrs	6	10%	12	20%
20 – 25	20	34%	25	41%
25 – 30	21	35%	15	25%
30 -35	10	16%	7	11%
>35	3	5%	1	3%
Total	60	100	60	100%

21 % patients in high risk group is above 30 years whereas it is only 14 % in low risk group

CHART 1:AGE OF PATIENT –STUDY GROUP

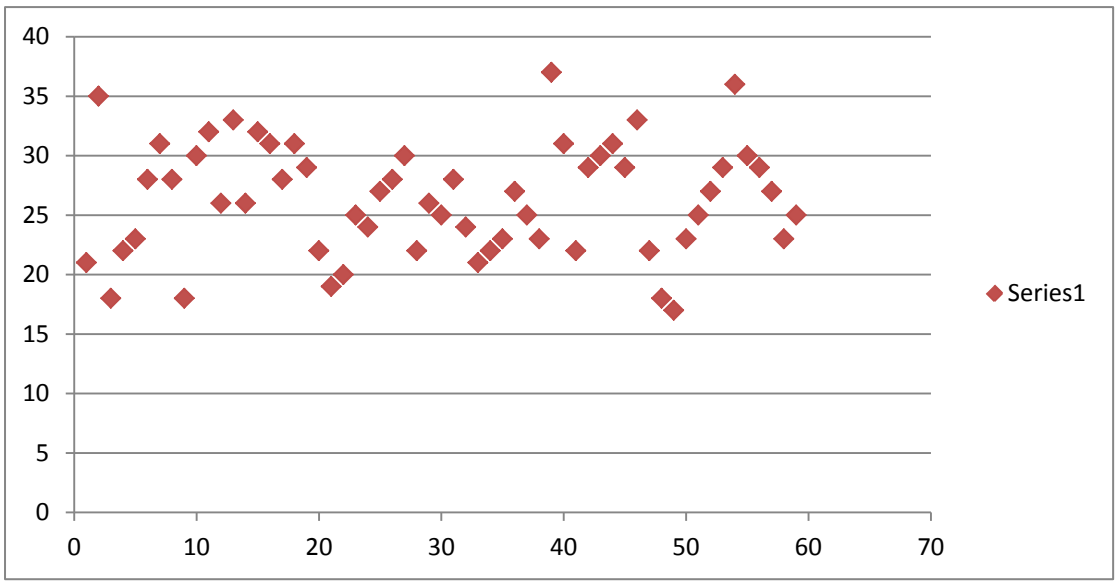


CHART 2- CONTROL GROUP AGE

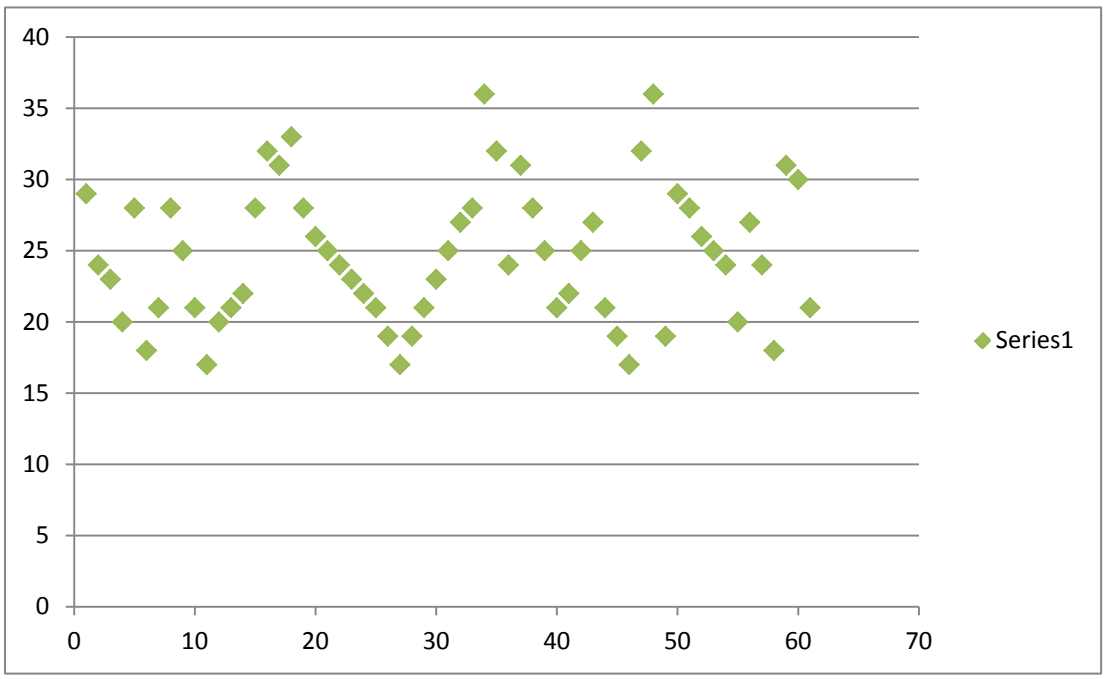


Table 2: MATERNAL CHARACTERISTICS

Characteristics	Group A	Group B
Nulliparous	50%	54.2%
BMI >25	26.7%	15%
Median maternal age	27 years	23 years

Mean maternal age is higher in high risk group.

Table – 3: Gestational Age

Gestational Age	No of patients –high risk group	%	No. of Patients-low risk group	%
28 -32weeks	18	30%	9	15%
33-37 weeks	36	60%	44	73.3%
37-42 weeks	6	10%	7	11.7%
Total	60	100%	60	100%

High risk patients are enrolled earlier than the low risk patients because of closer monitoring.

Table-4: Gravida

Gravida	NO OF PATIENTS – high risk group	%	NO OF PATIENTS- Low risk group	%
Primi	30	50%	35	54.2%
Multi	30	50%	25	45.8%

Table – 5: BMI

BMI	No. of Patients	%	No of controls	%
<20	18	30%	28	46.7%
21-25	26	43.3%	23	38.3%
26-30	13	21.7%	8	13.3%
31-35	3	5%	1	1.7%
>36	0	0%	0	0%
Total	60	100%	60	100%

26.7 % of high risk group patients are obese.

Table – 6: Haemoglobin

HB	No. of Patients	%	No of controls	%
<10.5	45	75	42	72.5%
>10.5	15	25	18	27.5%

Chi sqaure - 0.376, p value - 0.540. More than two third patients in both groups are anaemic and thedifference is not statistically significant

Table – 7 Systolic BP:

BP RANGE	**High risk patients**	**%**	**Low risk patients**	**%**
< 140	19	31.7%	49	81.7%
140 – 160	36	60%	11	18.3%
>160	5	8.7%	0	0%
Total	60	100%	60	100%

Table – 8: Diastolic BP

BP RANGE	NO OF PATIENTS	%	NO OF CONTROLS	%
<90	37	61.7%	51	85%
90-110	21	35%	9	15%
>110	2	3.3%	0	0%
Total	60	100%	60	100%

Both systolic and diastolic blood pressure were elevated in high risk group.

Table – 9 Selection of Cases

Cases	No. of Patients in study group	%
PREECLAMPSIA	19	31.66%
IUGR	9	15%
CHRONIC HYPERTENSION	2	3.33%
AUTOIMMUNE DISEASES	2	3.33%
BOH	3	5%
TYPE 2 DM	3	5%
COMBINATION OF MULTIPLE RISK FACTORS	22	36.66%
Total	60	100%

Preeclampsia is the most common risk factor followed by fetal growth restriction either alone or in combination with multiple risk factors

Table 10: Mean PI values

	Group A	GROUP B	P value	Significance
Mean uterine Artery PI	1.13	0.7	<0.001	Yes
Umbilical Artery PI	1.1	0.7	<0.001	Yes
Middle Cerebral Artery PI	1.4	1.3	0.728	No

The mean uterine artery PI and the umbilical artery PI are significantly higher in the high risk group compared to the low risk group wheres the middle cerebral artery PI does show much difference.

Table 11 : Independent student t tests for pulsatility indices

	VAR00002	N	Mean	Std. Deviation	P value
Middle cerebral Pulsatility index	1.00	60	1.408	.3356	T value -0.349, df -118
	2.00	60	1.392	.1555	P value - 0.728
Umbilical artery pulsatility index	1.00	60	1.193	.3277	T value - 9.694, df -118
	2.00	60	.872	.2624	P value <0.001
Meanuterineartery Pulsatility index	1.00	60	1.1308	.23526	T value -8.304, df -118
	2.00	60	.7292	.16398	P value <0.001

1 High Risk 2 Low Risk

Table 12: Comparision of Doppler Scores Between High Risk and Low Risk Patients

Score	High risk	Low risk
UTERINE ARTERY SCORE>0	66.66%	16.66%
BLOOD FLOW CLASSES>0	48.33%	8.33%
PLACENTAL SCORE>0	68.33%	16.66%

All the scores related to uterine and umbilical artery are more in high risk group, reflecting elevated impedence in the uteroplacental circulation.

PERINATAL OUTCOMES

TABLE 13: Mode of Delivery

Delivery	No. of Patients in high risk group	No of patients in low risk group	P value
Labour natural	29	54	<0.001
LSCS	31	6	<0.001

51.66 % in high risk group and only 10% patients in low risk group had operative delivery.

Chi square - 24.422, p value <0.001

Table 14: Operative Delivery for Fetal Distress

			VAR00002		Total
			1.00	2.00	
ODFD	.0	Count	29	50	79
		% within ODFD	36.7%	63.3%	100.0%
		% within VAR00002	48.3%	83.3%	65.8%
	1.0	Count	31	10	41
		% within ODFD	75.6%	24.4%	100.0%
		% within VAR00002	51.7%	16.7%	34.2%
Total		Count	60	60	120
		% within ODFD	50.0%	50.0%	100.0%
		% within VAR00002	100.0%	100.0%	100.0%

Chi square value - 16.338, p value - <0.001

Table 15 :Crosstab for Preterm Delivery

			VAR00002		Total
			1.00	2.00	
PRETERM BIRTH	0	Count	30	51	81
		% within PRETERM BIRTH	37.0%	63.0%	100.0%
		% within VAR00002	50.0%	85.0%	67.5%
	1	Count	30	9	39
		% within PRETERM BIRTH	76.9%	23.1%	100.0%
		% within VAR00002	50.0%	15.0%	32.5%
Total		Count	60	60	120
		% within PRETERM BIRTH	50.0%	50.0%	100.0%
		% within VAR00002	100.0%	100.0%	100.0%

Chi square - 16.752, p value - <0.001.

76.9% of thehigh risk patients had preterm birth either spontaneous onset or induced.

Table 16 :Crosstab for APGAR scores

			VAR00002		Total
			1.00	2.00	
APGAR	0	Count	30	50	80
		% within APGAR	37.5%	62.5%	100.0%
		% within VAR00002	50.0%	83.3%	66.7%
	1	Count	30	10	40
		% within APGAR	75.0%	25.0%	100.0%
		% within VAR00002	50.0%	16.7%	33.3%
Total		Count	60	60	120
		% within APGAR	50.0%	50.0%	100.0%
		% within VAR00002	100.0%	100.0%	100.0%

Chi square - 15.000, p value - <0.001

Low apgar scores are significantly higher in the patients with the elevated uterine artery doppler indices.

Table 17 :Cross tabulation for birth weight

			VAR00002		Total
			1.00	2.00	
BIRTH WEIGHT	0	Count	25	48	73
		% within BIRTHWEIGHT	34.2%	65.8%	100.0%
		% within VAR00002	41.7%	80.0%	60.8%
	1	Count	35	12	47
		% within BIRTHWEIGHT	74.5%	25.5%	100.0%
		% within VAR00002	58.3%	20.0%	39.2%
Total		Count	60	60	120
		% within BIRTHWEIGHT	50.0%	50.0%	100.0%
		% within VAR00002	100.0%	100.0%	100.0%

Chi square - 18.502, p value - <0.001

Preterm birth rate in the abnormal uterine doppler group is 58.3% whereas it is only 20% in the normal uterine artery doppler group.

Table 18: Crosstab for NICU Admission

			VAR00002		Total
			1.00	2.00	
NICUADMISSION	0	Count	29	46	75
		% within NICUADMISSION	38.7%	61.3%	100.0%
		% within VAR00002	48.3%	76.7%	62.5%
	1	Count	31	14	45
		% within NICUADMISSION	68.9%	31.1%	100.0%
		% within VAR00002	51.7%	23.3%	37.5%
Total		Count	60	60	120
		% within NICUADMISSION	50.0%	50.0%	100.0%
		% within VAR00002	100.0%	100.0%	100.0%

Chi square - 10.276, p value -0.002.

NICU admission rate is 51.7% in the high risk group whereas it is 23.3% in the low risk group with normal doppler.

Table 19: Cross Tab for Perinatal Mortality

			VAR00001		Total
			1.00	2.00	
PERINATAL MORTALITY	N	Count	58	60	118
		% within PERINATALMORTALITY	49.2%	50.8%	100.0%
		% within VAR00001	96.7%	100.0%	98.3%
	Y	Count	2	0	2
		% within PERINATALMORTALITY	100.0%	0.0%	100.0%
		% within VAR00001	3.3%	0.0%	1.7%
Total		Count	60	60	120
		% within PERINATALMORTALITY	50.0%	50.0%	100.0%
		% within VAR00001	100.0%	100.0%	100.0%

Mothers of both babies who died in the perinatal period had the highest uterine artery and the placental scores along with an absent/reversed end diastolic flow inthe umbilical artery.

Table 20: Incidence of Oligohydromnios

GROUP A	GROUP B	SIGNIFICANCE
40%	15%	0.004

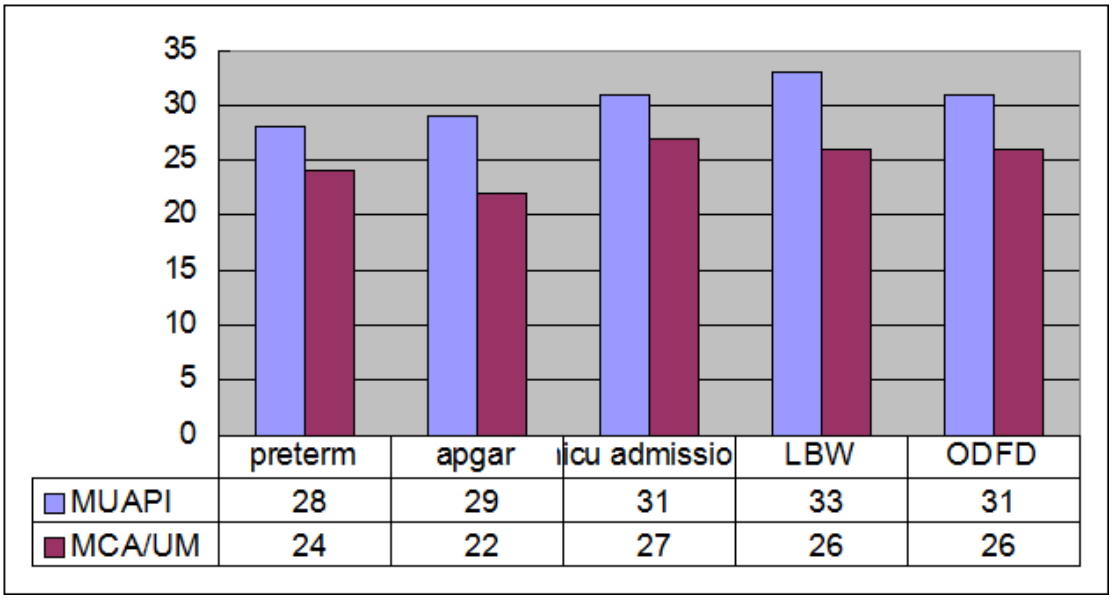
Chi square - 9.404, p value -0.004

Significantly higher incidence of oligohydromnios in the high risk group is noticed.

Table 21: Perinatal Outcome in Relation to Uterine and Umbilical Artery

	ODFD	BIRTH WEIGHT	APGAR	PRETERM BIRTH	NICU ADMISSION	PERINATAL MORTALITY
BOTH PI NORMAL	1	0	2	1	1	0
UTERINE-NORMAL UMBILICAL-ABNORMAL	0	0	2	1	0	0
UTERINE-ABNORMAL UMBILICAL-NORMAL	6	7	7	2	3	0
BOTH PI ABNORMAL	24	26	20	24	27	2

Bar Diagram: Mean Uterine Artery PI Versus Mca/Umbilical Ratio In Predicting Adverse Outcomes

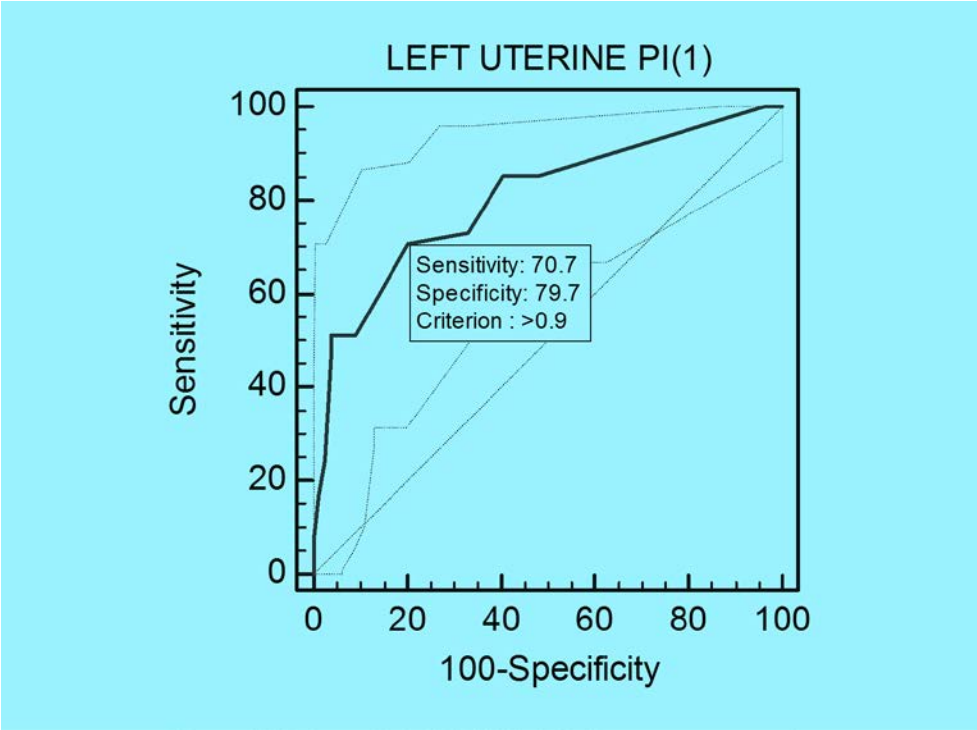


	preterm	apgar	icu admissio	LBW	ODFD
MUAPI	28	29	31	33	31
MCA/UM	24	22	27	26	26

All the adverse outcomes were better predicted by the elevated mean uterine artery pulsatility index.

It implies that the predictive value of the mean uterine artery pulsatility index is better than the middle cerebral/umbilical artery ratio.

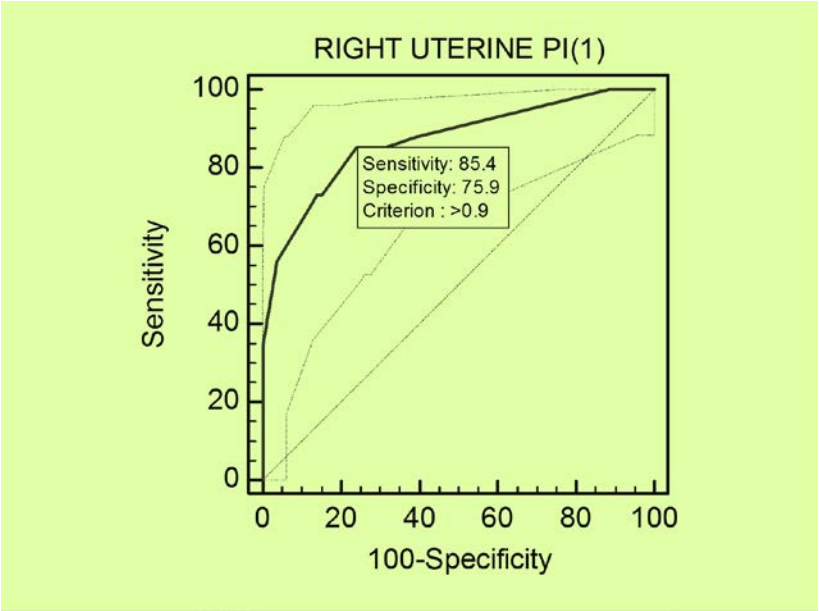
ROC for the left uterine PI in relation to ODFD



Youden index J	0.5048
Associated criterion	>0.9

Area under the ROC curve (AUC)	0.803952
Standard Error[a]	0.0437
95% Confidence interval[b]	0.721560 to 0.870776
z statistic	6.952
Significance level P (Area=0.5)	<0.0001

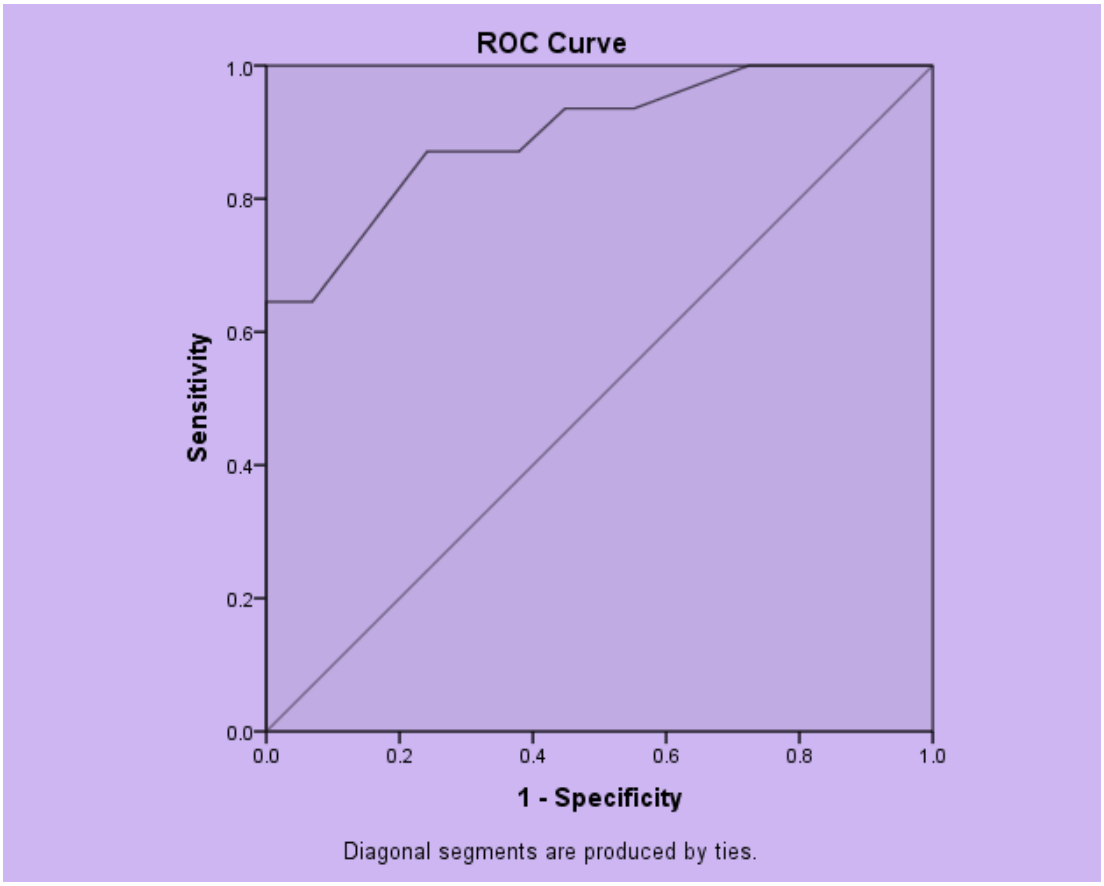
ROC for right uterine PI in relation to ODFD



Youden index J	0.6132
Associated criterion	>0.9

Area under the ROC curve (AUC)	0.870022
Standard Error[a]	0.0357
95% Confidence interval[b]	0.796418 to 0.924451
z statistic	10.374
Significance level P (Area=0.5)	<0.0001

ROC FOR MEAN UTERINE PI FOR ODFD



Area Under the Curve

Test Result Variable(s): meanuterinearteryPI

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.898	.039	.000	.822	.974

The test result variable(s):

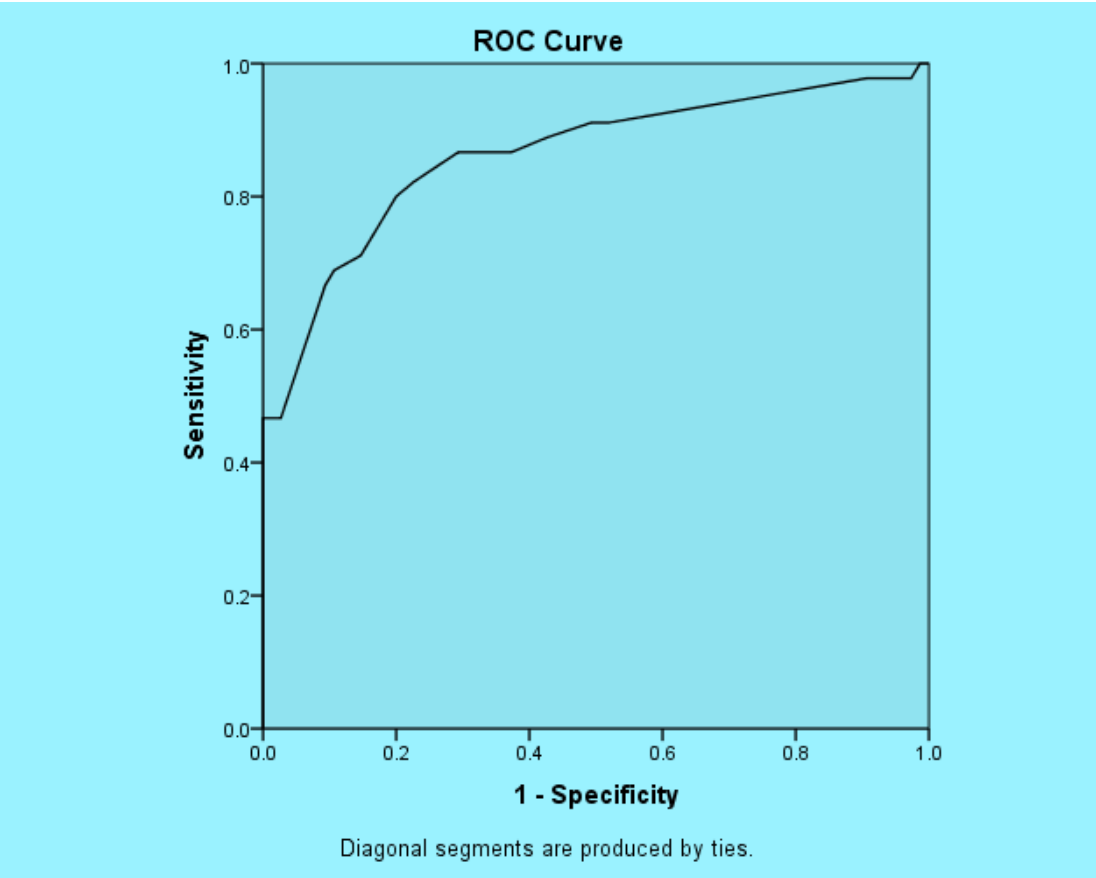
The mean uterineartery PI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

Optimal cut off - 1.075, sensitivity - 87.1, specifity -78.4

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

ROC MEAN TERINE ARTERY PI VERSUS NICU ADMISSION



Cut off - 0.9750, sensitivty - 80%, specificity - 80%

Area Under the Curve

Test Result Variable(s): mean uterine arteryPI

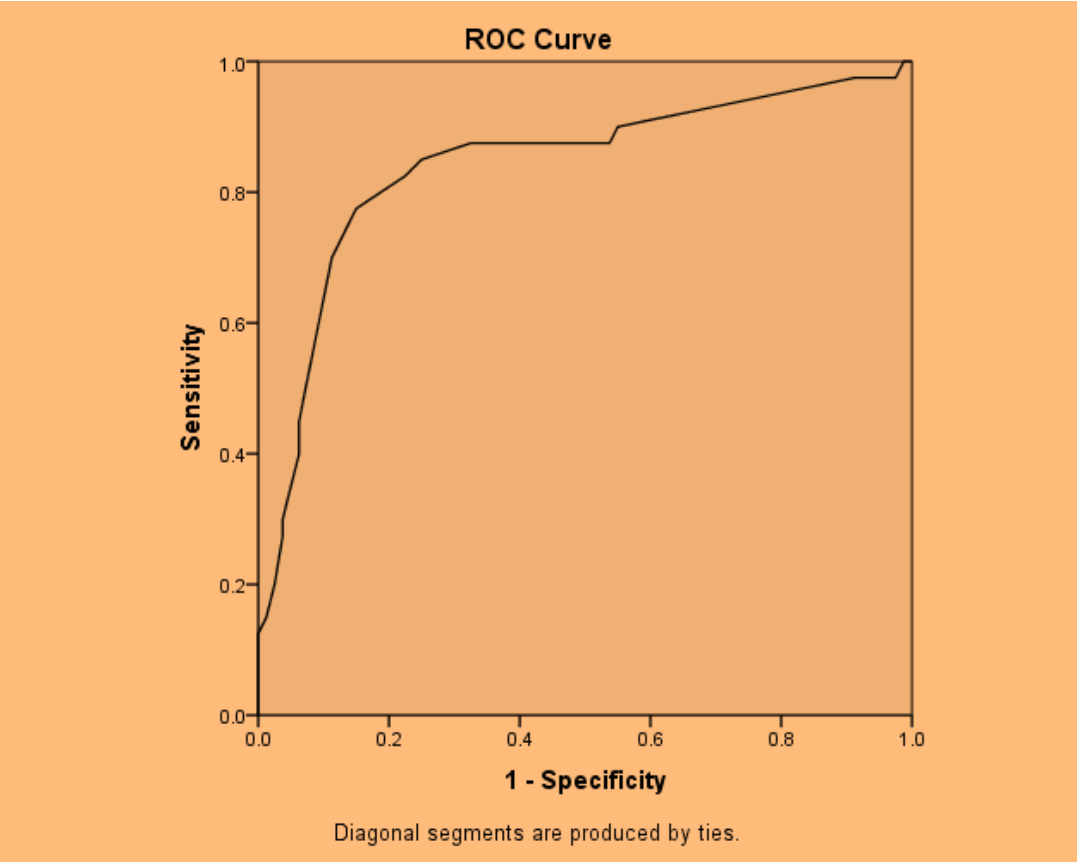
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.863	.038	.000	.789	.937

The test result variable(s): mean uterine artery PI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

ROC MEAN UTERINE ARTERY PI VERSUS APGAR



Cut off - 0.9750, sensitivty - 82.5% specificty - 77.5%

Area Under the Curve

Test Result Variable(s): mean uterine artery PI

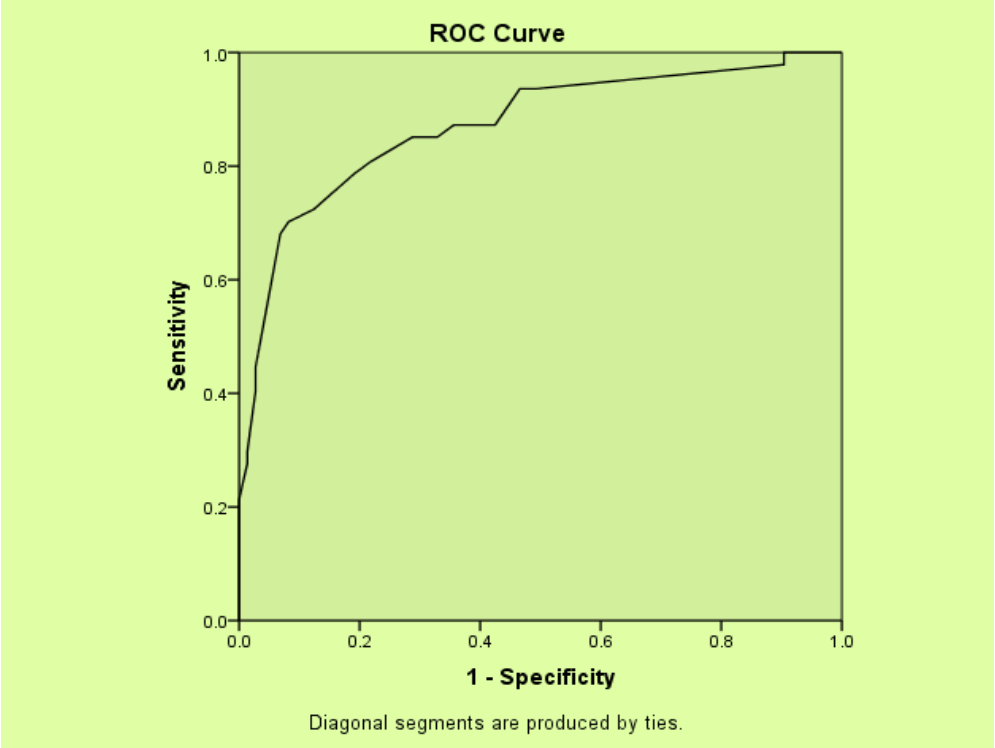
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.840	.043	.000	.756	.923

The test result variable(s): mean uterine arteryPI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

ROC MEAN UTERINE ARTERY PI VERSUS BIRTH WEIGHT:



Cut off - 0.9750, sensitivity - 78.7%, specificity - 80.8%

Test Result Variable(s): mean uterine artery PI

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.870	.035	.000	.802	.939

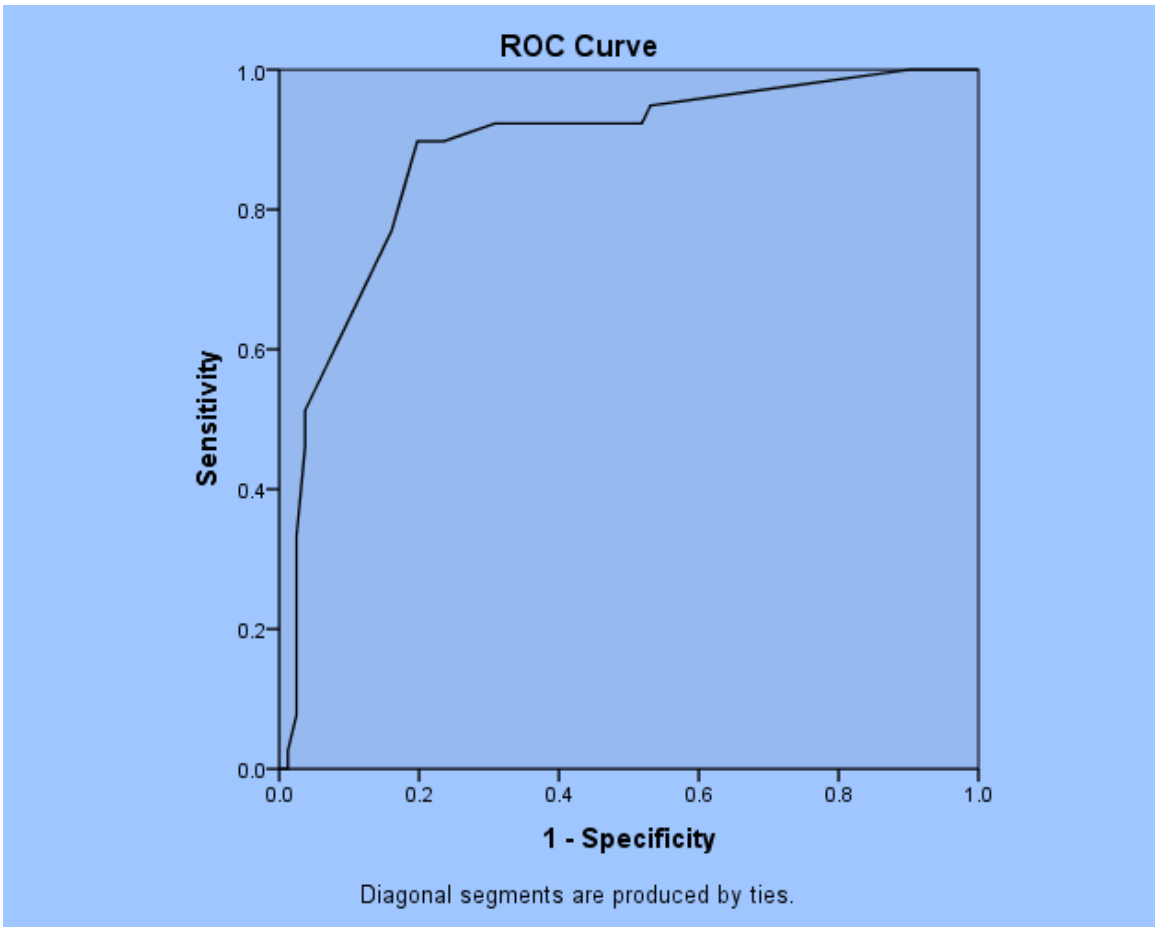
The test result variable(s): mean uterine artery PI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

ROC MEAN UTERINE ARTERY PI IN

RELATION TO PRETERM BIRTH



Cut off - 0.9750 sensitivity - 89.7%, specificity - 80.2%

Area Under the Curve

Test Result Variable(s): mean uterine artery PI

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.881	.034	.000	.813	.948

The test result variable(s): mean uterine artery PI has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

Table 22: Comparative Analysis of Left Uterine, Right Uterine and Mean Uterine Artery PI for Predicting 'Operative Delivery for Fetal Distress'

	Sensitivity	**specificity**	**Area under the ROC curve**	**Standard error**	**95% CI**	**Significant level P (Area=0.5)**
LEFT UTERINE PI	70.7%	79.7%	0.803952	0.0437	0.721560 to 0.870776	<0.001
RIGHT UTERINE PI	75.4%	85.9%	0.870022	0.0357	0.796418 to 0.924451	<0.001
MEAN UTERINE PI	87.1%	78.4%	0.898	0.039	0.822 to 0.974	<0.001
UTERINE ARTERY SCORE	70.7%	96.2%	0.8911	0.0337	0.8212 to 0.940668	<0.001

Uterine score has the highest specificity 96.2% for predicting operating delivery for fetal distress.

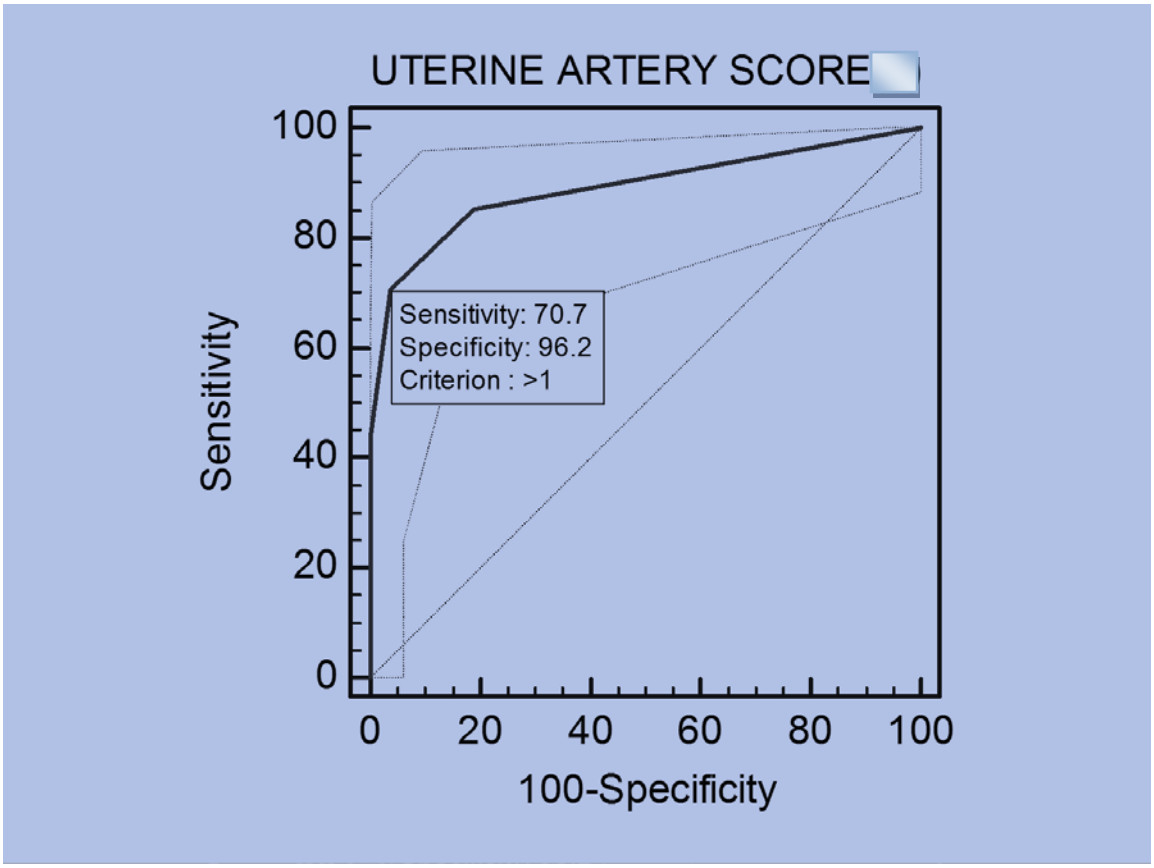
Mean Uterine artery PI has the highest sensitivity 87.1% for the same outcome.

Table 23: Receiver Operative Characteristic Analysis of Mean Uterine Artery PI With Relation to Adverse Perinatal Outcomes

	Sensitivity	Specificity	Area under curve	Std error	95% CI
ODFD	87.1%	78.4%	0.898	0.039	0.822 to 0.974
PRETERM BIRTH	89.7%	80.2%	0.881	0.034	0.813 to 0.948
APGAR<7	82.5%	77.5%	0.840	0.43	0.756 to 0.923
BIRTH WEIGHT	78.7%	80.8%	0.870	0.035	0.802 to 0.939
NICU ADMISSION	80%	80%	0.863	0.038	0.789 to 0.937

Mean uterine artery PI the best predictor of all adverse perinatal outcomes

ROC curve for Uterine Artery score in relation to operative delivery for fetal distress



Sample size		120
Positive group :	ODFD = 1	41
Negative group :	ODFD = 0	79

Area under the ROC curve (AUC)

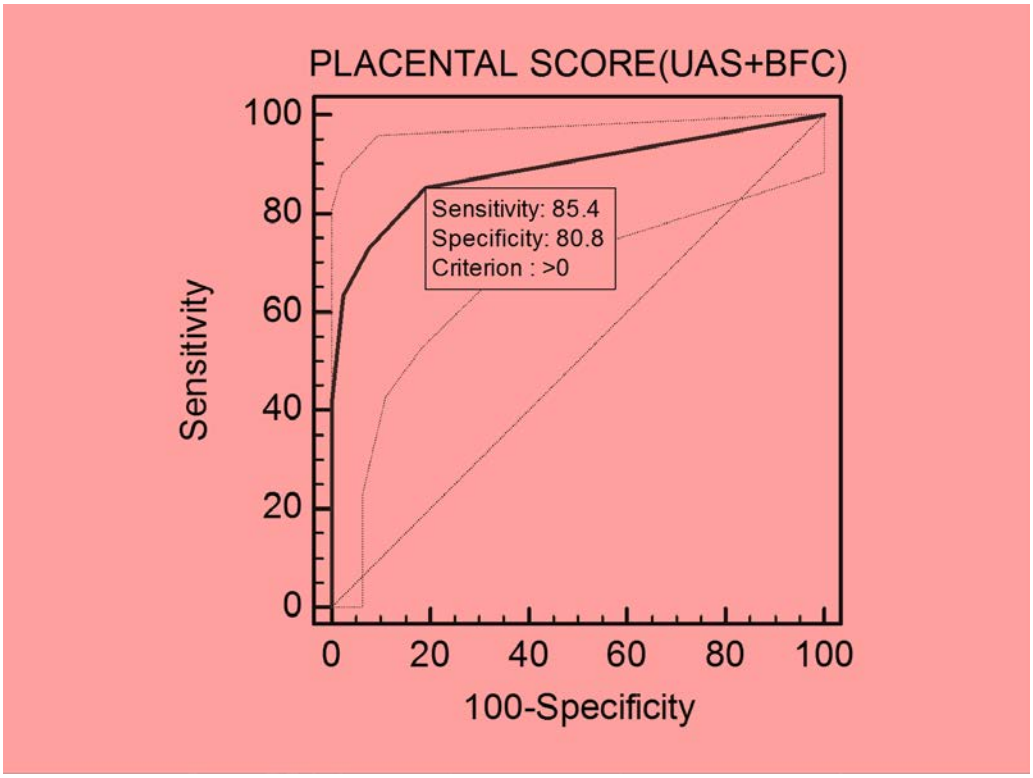
Area under the ROC curve (AUC)	0.891170
Standard Error[a]	0.0337
95% Confidence interval[b]	0.821282 to 0.940668
z statistic	11.611
Significance level P (Area=0.5)	<0.0001

Youden index J	0.6693
Associated criterion	>1

Criterion values and coordinates of the ROC curve:

Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100.00	91.4 - 100.0	0.00	0.0 - 4.6	1.00	
>0	85.37	70.8 - 94.4	81.01	70.6 - 89.0	4.50	0.18
>1	70.73	54.5 - 83.9	96.20	89.3 - 99.2	18.63	0.30
>2	43.90	28.5 - 60.3	100.00	95.4 - 100.0		0.56
>3	12.20	4.1 - 26.2	100.00	95.4 - 100.0		0.88
>4	0.00	0.0 - 8.6	100.00	95.4 - 100.0		1.00

ROC curve for placental score in relation to ODFD



Area under the ROC curve (AUC) :

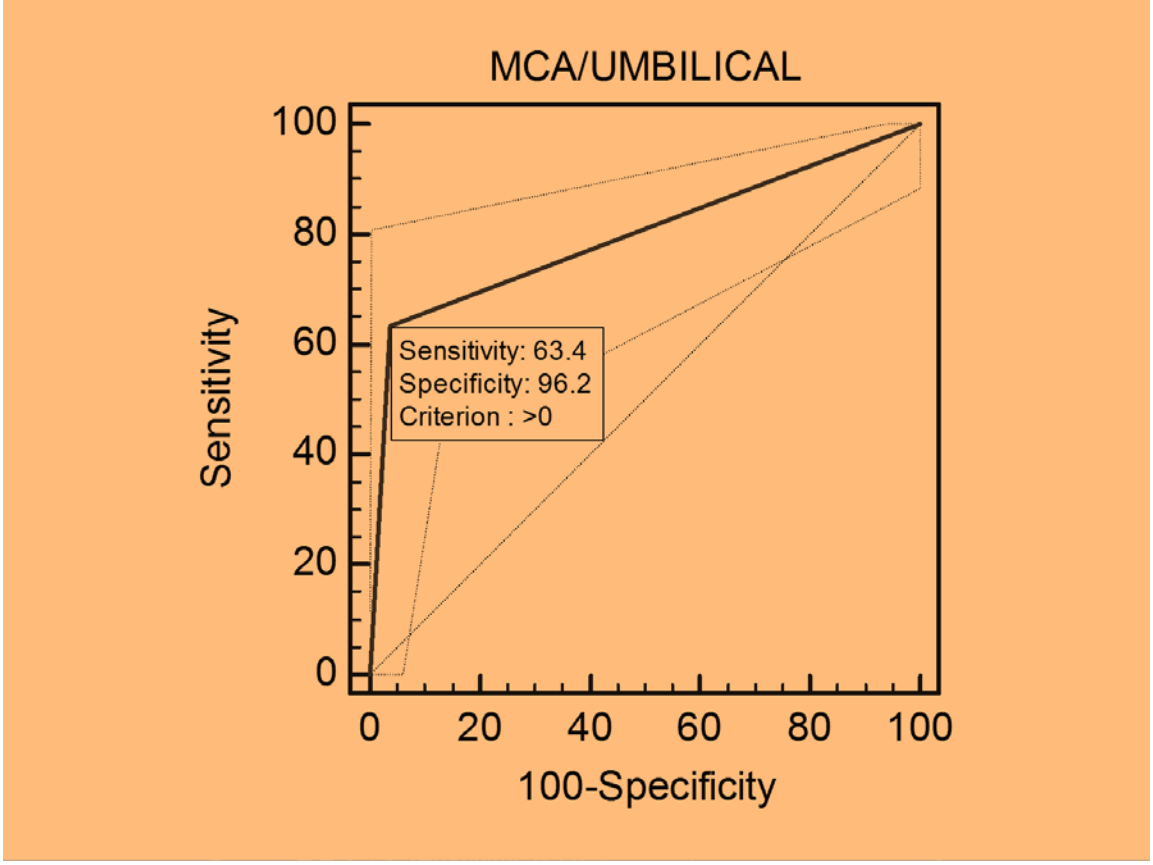
Area under the ROC curve (AUC)	0.888524
Standard Error[a]	0.0340
95% Confidence interval[b]	0.817785 to 0.938853
z statistic	11.439
Significance level P (Area=0.5)	<0.0001

Youden index J	0.6614
Associated criterion	>0

Criterion values and coordinates of the ROC curve for the placental score

Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0	100.00	91.4 - 100.0	0.00	0.0 - 4.6	1.00	
>0	85.37	70.8 - 94.4	80.77	70.3 - 88.8	4.44	0.18
>1	73.17	57.1 - 85.8	92.31	84.0 - 97.1	9.51	0.29
>2	63.41	46.9 - 77.9	97.44	91.0 - 99.7	24.73	0.38
>3	41.46	26.3 - 57.9	100.00	95.4 - 100.0		0.59
>4	21.95	10.6 - 37.6	100.00	95.4 - 100.0		0.78
>5	12.20	4.1 - 26.2	100.00	95.4 - 100.0		0.88
>6	2.44	0.06 - 12.9	100.00	95.4 - 100.0		0.98
>7	0.00	0.0 - 8.6	100.00	95.4 - 100.0		1.00

CEREBROPLACENTAL RATIO (MCA/UMBILICAL RATIO) IN RELATION TO ODFD



Area under the ROC curve (AUC)

Area under the ROC curve (AUC)	0.798086
Standard Error[a]	0.0396
95% Confidence interval[b]	0.715077 to 0.865839
z statistic	7.530
Significance level P (Area=0.5)	<0.0001

Table 24: Middle Cerebral Artery / Uterine Artery Ratio Crosstabulation in Relation to Preterm Birth

			MCA/UTERINE PI		Total
			0	1	
PRETERMBIRTH	0	Count	78	3	81
		% within PRETERM BIRTH	96.3%	3.7%	100.0%
		% within MCAUTERINE	92.9%	8.3%	67.5%
	1	Count	6	33	39
		% within PRETERM BIRTH	15.4%	84.6%	100.0%
		% within MCAUTERINE	7.1%	91.7%	32.5%
Total		Count	84	36	120
		% within PRETERM BIRTH	70.0%	30.0%	100.0%
		% within MCAUTERINE	100.0%	100.0%	100.0%

Fisher exact test, p value < 0.001.If MCA / uterine ratio is elevated, 84.6% patients had preterm birth.

Table 25: Severity of adverse outcomes in relation to grades according to uterine artery scores

			UTERINE ARTERY SCORE					Total
			.0	1.0	2.0	3.0	4.0	
ODFD	.0	Count	64	12	3	0	0	79
		% within ODFD	81.0%	15.2%	3.8%	0.0%	0.0%	100.0 %
		% within UTERINE ARTERYSCORE	91.4%	66.7%	21.4%	0.0%	0.0%	65.8%
	1.0	Count	6	6	11	13	5	41
		% within ODFD	14.6%	14.6%	26.8%	31.7%	12.2%	100.0 %
		% within UTERINE ARTERYSCORE	8.6%	33.3%	78.6%	100.0 %	100.0 %	34.2%
Total		Count	70	18	14	13	5	120
		% within ODFD	58.3%	15.0%	11.7%	10.8%	4.2%	100.0 %
		% within UTERINE ARTERYSCORE	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

100 % with uterine artery scores with 3 and 4 had operative delivery for fetal distress, whereas it is 78.6%, 33.3%, 8.6% for uterine artery scores 2, 1, 0 respectively.

Table 26: Cross Tabulation for Uterine Artery Score in Relation to NICU Admission

			UTERINE ARTERY SCORE					Total
			.0	1.0	2.0	3.0	4.0	
NICU ADMISSION	0	Count	61	11	3	0	0	75
		% within NICU ADMISSION	81.3%	14.7%	4.0%	0.0%	0.0%	100.0%
		% within UTERINE ARTERYSCORE	87.1%	61.1%	21.4%	0.0%	0.0%	62.5%
	1	Count	9	7	11	13	5	45
		% within NICU ADMISSION	20.0%	15.6%	24.4%	28.9%	11.1%	100.0%
		% within UTERINE ARTERY SCORE	12.9%	38.9%	78.6%	100.0 %	100.0 %	37.5%
Total		Count	70	18	14	13	5	120
		% within NICU ADMISSION	58.3%	15.0%	11.7%	10.8%	4.2%	100.0%
		% within UTERINE ARTERY SCORE	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0%

Similarly, 12.9 % patients with normal uterine artery doppler had NICU admission. Admission rates become progressively higher if scores are higher reaching upto 100% for scores 3 and 4.

Table 27: Crosstab for Uterine Artery Score in Relation to Perinatal Mortality

			UTERINE ARTERY SCORE					Total
			.0	1.0	2.0	3.0	4.0	
PERINATAL MORTALITY	0	Count	70	18	14	13	3	118
		% within PERINATAL MORTALITY	59.3%	15.3%	11.9%	11.0%	2.5%	100.0%
		% within UTERINE ARTERY SCORE	100.0%	100.0%	100.0%	100.0%	60.0%	98.3%
	1	Count	0	0	0	0	2	2
		% within PERINATAL MORTALITY	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
		% within UTERINE ARTERY SCORE	0.0%	0.0%	0.0%	0.0%	40.0%	1.7%
Total		Count	70	18	14	13	5	120
		% within PERINATAL MORTALITY	58.3%	15.0%	11.7%	10.8%	4.2%	100.0%
		% within UTERINE ARTERY SCORE	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Both perinatal mortality patients had uterine artery scores 4.

Table 28: Correlation Between the Uterine Artery Score, the Blood Flow Classes and the Placental Score

	Spearman correlation	P value
Uterine artery score against blood flow classes	0.763	<0.001
Placental score against blood flow classes	0.823,	<0.001
Placental score against uterine artery score	0.947,	<0.001

All the three scoring systems have very good correlating values in prediction of adverse perinatal outcomes

DISCUSSION

The maternal characteristics likethe age, the parity, the body mass index, the haemoglobin level, the systolic and diastolic blood pressure levels, the gestational age at the last doppler study before the delivery were compared between the high and the low risk groups.

GRAVIDA

50 % patients in the high risk group and 54.2% patients in the low risk group are nulligravida and the difference is not statistically significant.

RISK FACTORS ASSOCIATED

Preeclampsia is the most commonly associated risk factor in the high risk group. 70 % primigravida in the high risk group had preeclampsia either as a sole complication or in combination with fetal growth restriction and other risk factors. Fetal growth restriction is the second most commonly associated risk factor.

MATERNAL AGE

The mean maternal age in the high risk group and in the low risk group are 27 years and 23 years respectively. The advanced maternal age in the high risk patients may also contribute to the pregnancy complications.

BMI

26.7% patients in the high risk group and 15% patients in the low risk group have BMI > 25, which also accounts for the more frequent complications in the high risk group.

HAEMOGLOBIN LEVELS

More than 70% mothers in both the groups are anaemic but difference is not statistically significant.

Table 29: Comparision of Doppler Score between Present Study and Gudmundsson et al

	High risk patients	Low risk patients	Gudmundsson et al
UTERINE ARTERY SCORE>0	66.66%	16.66%	36.33%
BLOOD FLOW CLASSES>0	48.33%	8.33%	10.2%
PLACENTAL SCORE>0	68.33%	16.66%	40.2%

Doppler scores based on both uterine and umbilical arteries are elevated significantly in high risk group.

PERINATAL OUTCOMES

The frequency of operative delivery for fetal distress was 8.6 % with UAS 0, 33.3% with UAS 1, 78.6% WITH UAS 2, 100% with UAS 3 and 4, optimal cutoff being UAS 2. Uterine artery score of 1 had 70.7%sensitivity and 96.7% specificity for operative delivery for fetal distress.

More the impedance in the uterine arteries, the greater the frequency of perinatal adverse outcomes. All the scores and indices related to uterine artery and umbilical artery were elevated in study group when compared to control group. Uterine artery indices were elevated more than umbilical artery indices with respect to adverse outcomes.

Table 30: Comparision Table of Pulsatility Indices between the Present Study and a Study by Prashanth et al.

	High risk group	**Low risk group**	**P value**	**Significance in present study**	**Prashanth et al**
Mean uterine Artery PI	1.13	0.7	<0.001	Yes	1.02+-0.496(0.35-2.7)
Umbilical Artery PI	1.1	0.7	<0.001	Yes	1.09+-0.582(0.3-3.7)
Middle Cerebral Artery PI	1.4	1.3	0.728	No	1.52+-0.661(0.6-6)

The uterine artery and the umbilical artery pulsatility indices and the three score systems based on doppler parameters were compared with ROC analyses in relation to operative delivery for fetal distress,premature birth,

low birth weight, low apgar scores, and NICU admission rates. The mean uterine artery pulsatility index was the sigle best indicator of adverse perinatal outcomes, with optimal cutoff for ODFD being 1.07.

Regarding the score systems, the PLS was the best indicator of adverse outcome, followed by the UAS system. There is high degree of correlation between UAS, BFC andPLS in relation to all five outcome variables. Our present study found out that bilateral notching/high PI is more predictive of adverse outcomes than unilateral notching/ high PI.

Hofstaetter et al reported unilateral uterine artery notch to be abetter predictor than unilateral high PI. This is in contrast to findings of Ghosh et al where RI, PI, and notching were consideredto be equally predictive of adverse outcomes. We did not find any difference between notching and high PI as we think the uterine artery score as an integrated system rather than comparing the individual abnormalities.

PERINATAL DEATHS

Inspite of careful surveillance, there were two perinatal deaths, both cases diagnosed severe pre-eclampsia and iugr <30 weeks of gestation. Both mothers had UAS 4 and PLS 7, both regarded as indicators very high uteroplacental resistance. Both babies were delivered as early preterm, very low birth weight, had very poor apgar scores, prolonged NICU admission one died of severe respiratory distress syndrome and the other of intraventricular haemorrhage.

PREDICTION OF PRETERM BIRTH:

With respect to preterm birth, elevated middle cerebral /uterine artery ratio is the best predictor. 91.7 % patients with elevated ratio had preterm birth whereas only 7.1% patients with normal value had preterm birth. The difference is statistically significant.

Simanaviciute et al showed the middle cerebral / uterine arteryratio had sensitivity of 35.8%and specificity of 50% for preterm birth < 34 weeks and a sensitivity of 53.8% and specificity of 100% for preterm birth < 37 weeks.

41 out 60 patients (68%) in high risk group and 10 out of 60 (16%) patients in low risk group had elevated uterine artery scores. Out of them 28 had preterm delivery, 29 babies had low apgar scores, 31 had operative

delivery for fetal distress, 33 babies had low birth weight, 31 had NICU admission, all of which are statistically significant. So uterine artery doppler helps to identify among high risk patients who are prone to develop adverse pregnancy outcomes. Hence resources are utilised for their closer monitoring and better fetal surveillance.

It also identifies low risk patients without any clinical complications at the time of evaluation but are prone to develope adverse pregnancy outcomes later.

29 out 60 (48%) in high risk patients in high risk group and 5 out of 60 (8.3%) in low risk group had abnormal umbilical artery indices based on Blood flow classes (BFC).

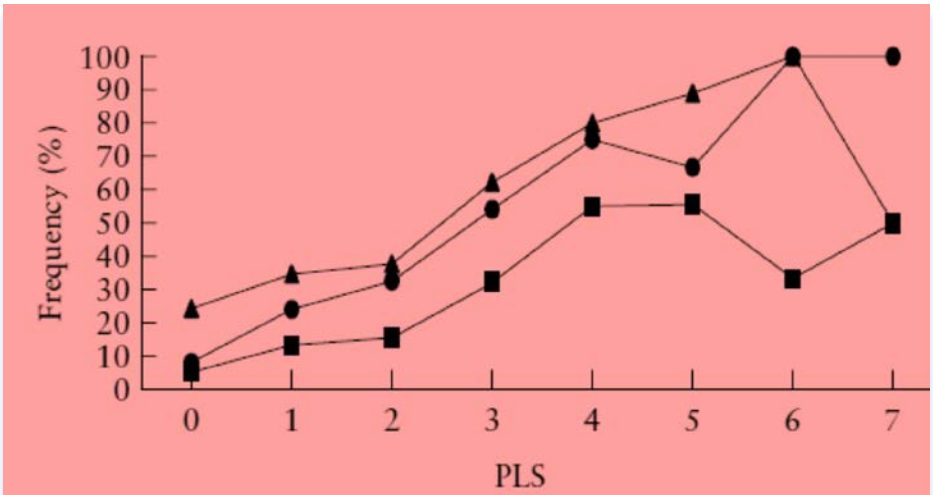


Figure 1 Frequency of premature birth (< 37 weeks) (●), small-for-gestational age newborns (■) and Cesarean section (▲) according to placental score (PLS).

Frequency of adverse outcomes based on Li et al.

Our present shows placental score (PLS) has very good sensitivity 85.4 % and specificity of 80.8% for adverse perinatal outcomes.

Simanaviciute and Gudmundsson found significant correlation with SGA newborn independently with abnormal cerebroplacental ratio and bilateral uterine artery notching.in the present study, 22 out of 60 (36%) in high risk group and 7out of 60 (11.6%) in low risk group had low cerebroplacental ratio. 2 patients had absent diastolic flow in umbilical artery. Out of 2, 1 had perinatal mortality and the had preterm delivery of a low birth baby with poor apgar and had prolonged NICU stay. 1 patient with reversed diastolic flow had perinatal mortality.

Patange and Goel et al have reported that the cerebroumbilical ratio in normal pregnancy is 1.77 ± 0.43. They noticed that this ratio is reduced to 1.47 (difference of 0.3) when there was placental insufficiency.In prent study,Cerebro placental ratio has low sensitivity of 63.4 % but a high specificity of 96.2% for adverse outcomes.

SUMMARY

In the present study, we found out the association between the third-trimester uterine artery blood flow velocimetric measurements and selected adverse perinatal outcomes in the high risk and the low risk groups of patients.

21% patients in the high risk group is above 30 years whereas it is only 14% in the low risk group.Mean maternal age is higher in the high risk group. 26.7% of the high risk group patients are obese. Preeclampsia is the most common risk factor followed by fetal growth restriction either alone or in combination with multiple risk factors. The mean uterine artery PI and the umbilical artery PI are significantly higher in the high risk group compared to the low risk group wheres the middle cerebral artery PI does show much difference.

All the scores related to uterine and umbilical artery are more in high risk group, reflecting elevated impedence in the uteroplacental circulation. 51.66 % in the high risk group and only 10% patients in the low risk group had operative delivery.76.9% of the high risk patients had preterm birth either spontaneous onset or induced. Low birth weight babies in the abnormal uterine doppler group is 58.3% whereas it is only 20% in the normal uterine artery doppler group. NICU admission rate is 51.7% in the

high risk group whereas it is 23.3% in the low risk group with normaldoppler.

The mean uterine artery PI has the highest sensitivity for predicting operative delivery for fetal distress 87.1% where as the highest specificity for the same outcome 96.2% is given by the uterine artery score.

We also found that patients with abnormal bilateral abnormalities, had more incidence of operative delivery for fetal distress, preterm deliveries, babies with poor apgar score, low birth weight, higher NICU admission rates among both high- and low-risk patients.

Our study supports the possibility that abnormal uterine artery doppler values indices can predict adverse perinatal outcomes even in the absence of apparent clinical complications.

The m ean uterine artery pulsatility index is the best predictor for adverse perinatal outcomes and the cut-of f for adverse outcomes in our study is 1.07. The uterine artery score, the blood flow classes and the placental score have very good degree of correlation in predicting adverse perinatal outcomes.The middle cerebral artery / uterine artery pulsatility index ratio is very good predictor of preterm birth.

We found that third-trimester uterine artery abnormal doppler changes among low-risk patients were also associated with higher frequency of adverse neonatal outcomes. This proves the possible role of the uterine

artery doppler to be included as a part a routine fetal surveillance even in low risk population.

When the abnormal uterine artery doppler indices and the pregnancy complications are combined, the perinatal outcomes are worse.

The uterine artery doppler is very useful in subset of patients with fetal growth restriction and normal umbilical artery doppler, because high impedence in uteroplacental circulation is predicted better and earlier by the uterine artery doppler.

CONCLUSION

The current study found that uterine artery doppler indices may be included along with umbilical and middle cerebral artery doppler indices to improve fetal surveillance. It helps to predict adverse perinatal outcomes, optimises monitoring and in preventing complications. Adverse perinatal outcomes after 34 weeks of gestation are better predicted with the uterine doppler than the umbilical doppler. Normal uterine doppler in high risk pregnancies inthird trimester is reassuring.

Mean uterine artery PI is very good predictor of adverse perinatal outcomes. The uterine artery score based on bilateral uterine artery velocimetry indices and the blood flow classes based on umbilical artery doppler velocimetry indices are complimentary to each other and the combined scoring system called placental score proves a long way ahead in third trimester fetal surveillance to achieve optimal perinatal outcomes. Scoring system comprising the doppler indices is better than the independent ratios in the third trimester fetal surveillance.

LIMITATIONS

The limitation of this study is that number of cases has been small. The confounding factor may be the use of antihypertensive agents which may to some extent bring about resistance changes in the uterine vessel. We are also aware that beyond 37 weeks, the placenta tries to compensate for the placental insufficiency by remodelling itself. Patients who came in labour or with complications like abruptio placenta, eclamptic fits were not included in the study which could have provide additional information regarding severity of doppler changes. We had a group of mixed high risk pregnancies like autoimmune diseases, bad obstetric history, postdated pregnancies etc which might have their own way of patterns of uterine vascular changes to dilute or confound the results.

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PROFORMA

SERIAL NO.: **DATE OF ENROLLING IN THE STUDY :**

NAME: **AGE:** **OP/IP. No.:** **UNIT:**

SOCIO-ECONOMIC STATUS:

BOOKED: **YES / NO**

IMMUNISED: **YES / NO**

HISTORY OF PRESENT ILLNESS:

MENSTRUAL HISTORY: **REGULAR / IRREGULAR**

LMP **EDD**

MARITAL HISTORY: **MARRIED SINCE**

CONSANGUINITY

OBSTETRIC HISTORY: **G** ☐ **P** ☐ **L** ☐ **A** ☐

: **LCB**

<u>PREVIOUS OBSTETRIC HISTORY</u>:

DETAILS OF PREVIOUS OBSTETRIC OUTCOME:

PERSONAL HISTORY: **SMOKER** **YES / NO**
ALCHOLIC **YES / NO**
MIXED DIET **YES / NO**

HIGH RISK FECTORS

1. **FETAL GROWTH RESTRICTION** ☐
2. **HYPERTENSIVE DISORDERS OF PREGNANCY** ☐
3. **DIABETES COMPLICATING PREGNANCY** ☐
4. **AUTO IMMUNE COMPLICATING PREGNANCY** ☐
5. **BAD OBSTETRIC HISTORY** ☐
6. **POSTDATED PREGNANCY** ☐
7. **OTHERS** ☐

GESTATIONAL AGE (BY DATES) :

GESTATIONAL AGE (BY CLINICALLLY) :

GENERAL EXAMINATION.

HEIGHT:

WEIGHT:

ANEMIA:

EDEMA:

PULSE: **BP:**

CVS: **RS:**

OBSTETRIC EXAMINATION

SYMPHYSIO FUNDAL HEIGHT :

ABDOMINAL GIRTH :

LIQUOR VOLUME :

FETAL HEART :

USG AND DOPPLER

DATE :

NUMBER :

PRESENTATION :

BPD :

HC :

AC :

FL :

AFI :

EXPECTED BIRTH WEIGT :

DOPPLER

UTERINE ARTERY DOPPLER:

MEAN UTERINE ARTERY PI:

UTERINE ARTERY SCORE:

UMBILICAL ARTERY PI :

ABSENT /REVERSED END DIASTOLIC FLOW: YES/NO

BLOOD FLOW CLASSES:

PLACENTAL SCORE(UAS+BFC):

MIDDLE CEREBRAL ARTERYPI :

CEREBROPLACENTAL RATIO:

MCA/UTERINE PI RATIO:

OTHER INVESTIGATIONS

URINE : ALBUMIN

DEPOSITS

HAEMOGLOBIN :

BLOOD UREA :

SUGAR :

SE. CREATININE :

OTHERS :

FOLLOW UP DETAILS :

PERINATAL OUTCOMES:

MODE OF DELIVERY: LABOUR NATURAL/ LSCS

REASON FOR TERMINATION

GESTATIONAL AGE AT DELIVERY:

NEONATAL OUTCOME:

LIVE BORN STILL BORN

APGAR IMIN 5 MINS ☐

BIRTH WEIGHT IN KG: SEX OF THE BABY M ☐ **F** ☐

NEONATAL MORBIDITY : YES ☐ **NO** ☐

RESPIRATORY DISTRESS :

ADMISSION TO NICU :

REASON :

DURATION OF ADMISSION :

CONDITION ON DISCHARGE :

NEONATAL DEATH :

OUT COME :

CONSENT FORM

STUDY TITLE:

"The Prospective Observational Study to evaluate the role of Uterine Artery Doppler velocimetry indices for third trimester fetal surveillance in predicting Adverse perinatal Outcomes

STUDY CENTRE: Institute of Social Obstetrics and Govt. KGH, Chennai.

PARTICIPANT NAME :

AGE: **SEX**: **J.D.NO.**

I confirm that I have understood the purpose of procedure for the above study, I have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I have been explained about the possible complications that may occur during the procedure, I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving any reason.

I understand that investigator, regulatory authorities and the ethics committee will not need my permission to look at my health records both in respect to the current study and any further research that may be conducted in relation to it, even if I withdraw from the study. I understand that my identity will not be revealed in any information released to third parties of published, unless as required under the law. I agree not to restrict the use of any or results that arise from the study.

I hereby consent to participate in this **“The Prospective Observational Study to evaluate the role of Uterine Artery Doppler velocimetry indices for third trimester fetal surveillance in predicting Adverse perinatal Outcomes**

Signature of Investigator: Place :

Date :

Study Investigators Name: Institution:

Signature / Thumb Impression

Thanking you,

Yours faithfully,

INFORMATION SHEET

We are conducting a study on **"The Prospective Observational study to evaluate the role of Uterine Artery Doppler velocimetry indices for third trimester fetal surveillance in predicting adverse perinatal Outcomes"** among patients attending Kasturba Gandhi Government Hospital Chennai and for that your clinical details may be valuable to us.

- We are selecting certain patients and if you are found eligible, we may be using your clinical details in such a way so as to not affect your final report or management.
- The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.
- Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.
- The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of investigator Signature of participant

Date: Date:

சுயஒப்புதல்படிவம்

ஆய்வுசெய்யப்படும்தலைப்பு:. பாதகமான பிறப்பு சார்ந்த விளைவுகளைகணிப்பதில், கர்ப்பபை இரத்தஓட்டகுறீயீடுகளில் ஏற்படும் மாற்றங்களை பற்றிய வருங்கால கண்காணிப்பு ஆய்வு, அரசு கஸ்தூரிபாய் காந்திதாய் சேய் நல மருத்துவமனை மற்றும் சமூகமகப்பேறுயியல்மையம்

பங்குபெறுபவரின்பெயர் :

பங்குபெறுபவரின்வயது : **பங்குபெறுபவரின்எண் :**

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. நான் இவ்வாய்வில் தன்னிச்சையாக பங்கேற்கிறேன். எந்தகாரணத்தினாலோ எந்தசட்டசிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகிக்கொள்ளல்லாம் என்றும் அறிந்துகொண்டேன்.

இந்த ஆய்வுசம்பந்தமாகவோ, இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவஅறிக்கைகளை பார்ப்பதற்கு என் அனுமதிதேவையில்லை என அறிந்துகொள்கிறேன். இந்த ஆய்வின்மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக்கொள்ள மறுக்கமாட்டேன்.

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்றும் உறுதியளிக்கிறேன்.

பங்கேற்பவரின்கையொப்பம்

இடம் :

தேதி :

சாட்சியாளரின் கையொப்பம்

இடம் :

தேதி :

பங்கேற்பவரின்பெயர்மற்றும்விலாசம் :

ஆய்வாளரின்கையொப்பம் :

இடம் : தேதி :

CASES(60)	AGE	GRAVIDA	BMI	HAEMOGLOBIN	SE CLASS	SYSTOLIC BP	DIASTOLIC BP	PROTEINURIA	GA AT DOPPLER	RIGHT UTERINE PI(1)	LEFT UTERINE PI(1)	RIGHT UTERINE NOTCH(1)	LEFT UTERINE NOTCH(1)	UTERINE ARTERY SCORE(4)	MCA PI	MCA /UTERINE	UMB PI	MCA/UMBILICAL	BFC(BLOOD FLOW CLASSES)	PLACENTAL SCORE(UAS+BFC)	OLIGO	PREECLAMPSIA COMPLICATIONS	PRETERM BIRTH	BIRTH WEIGHT	APGAR	ODPD	NICU ADMISSION	PERINATAL MORTALITY
annapoorani	1	1	2	1	3	3	3	1	32	1.4	1.3	1	0	3	1.6	1	1.7	1	2	5	1	1	1	1	1	1	1	0
meenakshi	4	1	3	1	3	2	2	1	29	1.7	1.5	1	1	4	1.8	1	2	1	3	7	1	1	1	1	1	1	1	1
aarthi	1	1	2	1	4	2	1	1	33	1.3	1	0	0	1	2	0	0.8	0	1	2	0	0	0	1	1	0	0	0
kavitha	2	1	2	1	4	3	2	1	34	1.3	1	1	0	2	1.6	1	0.8	0	1	3	1	0	1	1	1	1	1	0
sunitha	2	1	3	1	2	3	3	1	33	1.5	1.3	1	1	4	1.9	1	2	1	2	6	1	0	1	1	1	1	1	0
rekha	3	1	2	1	3	2	2	1	35	1	1.3	0	1	2	2	1	0.8	0	1	3	1	0	1	1	1	1	1	0
deepa	4	0	1	1	4	2	2	1	34	1.2	1.3	0	1	3	0.8	1	0.9	1	2	5	1	0	1	1	1	1	1	0
nisha	3	1	2	1	2	2	2	0	28	1	1.1	0	1	1	1.8	1	1	0	0	1	1	0	1	0	0	0	0	0
sharmila	1	0	3	0	3	3	2	1	30	1.4	1.5	0	1	3	1	1	1.1	1	1	4	1	0	1	1	1	1	1	0
shobana	3	0	2	1	5	2	2	1	38	1.3	1	1	0	2	1.4	1	1	0	0	2	0	0	1	1	1	1	1	0
padmapriya	4	1	1	1	4	1	2	1	35	1.8	1.7	1	1	4	0.9	1	1.5	1	2	6	1	1	0	1	1	1	1	0
glory	3	1	4	0	4	2	2	1	35	1.5	1.5	1	0	3	1.3	1	1.4	1	1	4	1	0	0	1	1	1	1	0
faritha	4	0	4	1	3	2	1	1	29	1.3	1.4	0	1	3	1.1	0	1.2	1	1	4	0	0	1	0	1	1	1	0
soniya	3	1	3	1	3	3	2	1	34	1.4	1.3	1	0	3	1.6	1	1.6	1	0	3	0	0	1	1	0	1	1	0
palaniyammal	4	1	4	1	5	2	1	1	34	1.5	1.4	1	1	4	1.4	1	1.5	1	2	6	1	0	1	1	0	1	1	0
balajothi	4	0	1	0	3	1	2	0	33	1.5	1.3	1	1	4	1.5	1	1.6	1	2	6	1	0	1	1	0	1	1	1
chithra	3	0	2	1	3	2	2	1	34	1.4	1.3	1	0	3	1.2	1	1.2	1	1	4	1	0	1	1	1	1	1	0
femina	4	1	2	1	3	2	1	1	37	1.3	1	1	0	2	1.5	0	1.3	0	0	2	0	0	0	1	0	1	1	0
kalaivani	3	1	1	1	4	2	1	1	34	1.4	1.2	1	0	3	1	1	1.1	1	1	4	1	0	1	1	1	1	1	0
kanimozhi	2	0	1	1	5	1	1	0	36	1.3	1	1	0	2	0.8	1	1	0	0	2	0	0	1	1	1	0	0	0
abitha	1	0	3	0	3	2	1	1	35	1.5	1	1	0	2	1.5	0	1.6	1	0	2	0	0	0	0	0	1	1	0
esther	1	0	1	1	4	2	1	1	30	1	1.3	0	1	2	1.2	1	1.5	1	0	2	0	0	1	1	1	0	0	0
hemalatha	2	0	3	0	3	2	2	1	34	1.5	1.3	1	0	3	1	1	1	1	1	4	1	0	1	1	1	1	1	0
xiong pi	2	0	1	1	4	2	1	1	37	1.3	1.2	1	0	3	1	1	1.1	1	1	4	1	0	1	1	1	1	1	0
nirupama	3	1	2	0	5	2	2	1	36	1.3	1	0	0	1	1.4	0	0.8	0	0	1	0	0	0	0	0	1	1	0
nithya	3	1	1	1	4	1	2	1	32	1.4	0.9	1	0	2	1.3	0	1.2	0	1	3	1	0	1	1	1	1	1	0
akalya	3	1	2	1	3	2	2	1	34	1.5	1	1	0	2	1	0	1.1	1	1	3	1	0	1	1	0	1	1	0
muthulakshmi	2	1	1	1	3	1	1	0	35	1	1.3	0	0	1	1.3	0	1.4	0	0	1	0	0	0	0	0	1	1	0
lakshmi	3	1	1	1	4	2	1	0	36	1.3	0.9	0	0	1	1.4	0	1	0	0	1	0	0	0	0	0	0	0	0
neelaveni	2	0	3	0	3	2	2	1	29	1.5	1	1	1	3	1.1	1	1.1	1	2	5	1	0	1	1	1	1	1	0
ayesha	3	1	1	1	4	2	2	1	30	1.4	1	1	0	2	1	1	1.1	1	1	0	0	0	1	1	1	0	0	0
narmada	2	0	2	0	4	1	1	0	32	1.3	1	0	0	1	1.1	0	0.8	0	0	1	0	0	0	0	0	0	0	0
ilaveni	2	1	1	1	4	1	2	0	34	1.4	0.7	0	0	1	1.5	0	0.7	0	0	1	1	0	0	0	0	0	0	0
fathima	2	0	2	1	3	1	1	0	39	1.3	0.8	0	0	1	0.8	0	0.9	0	1	2	1	0	0	0	1	0	0	0
thangam	2	0	3	1	3	2	2	1	34	1	1	1	0	1	1.7	0	1.5	0	0	1	0	0	0	0	0	1	0	0
bincy	3	1	3	0	4	2	1	1	34	1	0.9	0	0	0	1.3	0	1	0	0	0	0	0	0	0	0	0	1	0
nasrin	2	0	2	1	3	1	1	0	31	1	0.7	0	0	0	1.1	0	0.5	0	0	0	0	0	0	0	0	0	0	0
vennila	2	0	2	0	4	1	1	0	35	1	0.8	0	0	0	1	0	1.3	0	0	0	0	0	0	0	0	1	1	0
mekala	5	0	1	1	3	2	1	1	38	0.7	0.8	0	0	0	1.5	0	1.2	0	0	0	0	0	0	0	0	0	0	0
mubeena	4	0	2	0	4	1	1	0	35	0.6	0.9	0	0	0	1.4	0	1.5	0	0	0	1	0	0	1	0	0	0	0
vaishavi	2	0	2	1	3	2	1	0	30	0.8	1	0	0	0	1.3	0	1.1	0	0	0	0	0	0	0	0	0	0	0
ramya	3	0	2	1	3	2	1	0	30	0.9	1.1	0	0	0	1.7	0	1.1	0	0	0	0	0	1	0	0	0	0	0
subbulakshmi	3	0	3	1	3	2	1	0	33	0.8	0.9	0	0	0	2	0	1.3	0	0	0	0	0	0	0	0	0	0	0
manimeghalai	4	1	2	1	4	1	1	0	38	1	0.8	0	0	0	1.9	0	1.4	0	0	0	0	0	0	0	0	0	0	0
subha	3	1	3	1	3	1	1	0	32	1.1	0.7	0	0	0	1.3	0	1.1	0	0	0	0	0	0	0	0	0	0	0
meenakshi	4	1	2	0	5	2	1	1	37	1	0.8	0	0	0	1.2	0	1.3	0	0	0	0	0	0	1	0	1	1	0
pallavi	2	1	1	1	5	2	1	1	34	0.8	0.9	0	0	0	1.1	0	0.8	0	0	0	0	0	0	0	0	0	0	0
jayanthi	1	1	1	1	5	2	1	0	39	0.9	1	0	0	0	1.4	0	1	0	0	0	0	0	0	0	0	0	0	0
valarmathi	1	1	2	1	5	2	1	1	37	0.7	1.1	0	0	0	1.4	0	1.5	0	0	0	0	0	0	0	0	0	0	0
vidhyarani	2	1	2	1	2	1	1	1	36	0.9	0.8	0	0	0	1.4	0	1	0	0	0	0	0	0	0	0	0	0	0
poornima	2	1	2		1	3	2	1	1	31	1.3	0.7	1	0	0	1.7	1	1.1	0	1	3	0	0	1	1	1	0	0	0
dhivya	3	0	2	0	4	1	1	0	34	1.4	1	1	0	0	1.5	1	0.9	0	1	3	1	0	1	1	1	0	0	0
rajeshwari	3	0	1	1	3	2	1	0	32	1	0.9	0	0	0	1.5	0	0.8	0	0	0	0	0	0	1	1	0	0	0
muthulakshmi	5	1	3	0	4	1	1	0	29	1.4	0.6	0	0	1	1.9	1	0.9	0	1	1	1	0	1	1	1	1	1	0
arivuselvi	3	1	1	1	5	1	2	1	36	1.2	0.6	0	0	1	1.4	1	1.2	0	1	1	0	0	1	1	1	0	0	0
kanmani	3	0	2	1	5	1	1	0	30	1	0.7	0	0	0	1.9	0	1.5	0	0	0	0	0	0	0	0	0	0	0
elavarasi	3	1	1	1	3	2	1	1	41	0.7	0.5	0	0	0	1.7	0	1.6	0	0	0	0	0	0	0	0	0	0	0
saranya	2	1	3	1	4	2	1	1	34	1.6	1.4	1	0	3	1.9	1	1.9	1	1	5	0	0	1	1	1	1	1	0
sangeetha	2	0	2	0	2	1	1	0	33	1.4	1.6	0	1	3	1.5	1	1.5	1	1	4	0	0	1	1	1	1	1	0
aarthi	1	1	2	1	4	2	1	1	38	1.3	1	0	0	1	2	0	0.8	0	1	1	0	0	0	1	1	0	0	0

CONTROLS(60)																													
priya	1	1	4	1	3	1	1	1	28	1.7	0.8	1	0	2	1.4	1	1.4	1	1	3	1	0	1	1	1	1	1	0
naseera	2	0	2	1	4	1	1	0	32	0.7	1.5	0	1	2	1.8	1	1.8	1	1	3	1	0	1	1	1	1	1	0
dong piong	1	0	3	0	5	1	1	1	34	1.4	0.6	0	0	1	0.9	1	0.9	1	0	1	0	0	1	0	0	1	1	0
christy	1	1	1	1	5	1	1	0	36	1.5	0.6	1	0	2	1.7	1	1.7	1	1	3	0	0	1	1	1	1	1	0
thirupathamma	1	1	2	1	4	1	2	1	36	1.5	0.8	0	1	2	1.4	1	1.4	1	1	3	0	0	1	1	1	1	1	0
thangalakshmi	2	0	2	1	3	1	1	0	39	0.7	1.6	0	0	1	1.6	1	1.6	1	1	2	1	0	0	1	1	1	1	0
tamilselvi	2	1	1	0	4	1	2	1	36	0.7	0.6	0	1	1	1.4	1	0.9	0	0	1	0	0	1	0	0	0	1	0
hajira	2	1	2	1	3	1	1	0	36	0.6	1.4	0	0	1	1.4	1	0.4	0	0	1	0	0	1	0	0	0	0	0
mariyam	3	1	1	0	4	1	2	0	35	0.7	0.6	0	0	0	1.3	0	0.9	0	0	0	0	0	0	0	0	0	0	0
shilpa	2	1	2	0	5	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
harini	2	1	2	1	4	1	2	0	36	0.7	0.9	0	0	0	1.2	0	0.6	0	0	0	0	0	0	0	0	0	0	0
surya	2	0	3	1	1	2	1	0	36	0.8	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	1	0	0	0
chithraleka	2	1	1	1	4	1	2	1	40	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
rupa	2	1	1	0	3	1	1	0	36	0.7	0.6	0	0	0	1.8	0	0.7	0	0	0	0	0	0	0	0	0	0	0
veni	2	1	1	1	5	1	1	0	36	0.6	0.6	0	0	0	1.7	0	0.9	0	0	0	0	0	0	0	0	0	0	0
arputhamary	2	1	1	0	3	1	1	0	31	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
karthika	1	0	2	1	4	1	1	0	36	0.7	0.9	0	0	0	1.4	0	0.6	0	0	0	1	0	0	0	0	0	0	0
yesamma	3	0	2	1	4	2	1	1	36	0.5	1.5	0	0	1	1.3	0	0.9	1	0	1	0	0	0	1	0	0	1	0
latharani	3	1	3	0	4	1	2	0	33	0.7	0.6	0	0	0	1.4	0	0.8	0	0	0	0	0	0	0	0	0	0	0
jesitha	4	1	1	1	3	1	2	1	35	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	1	0
thasleem	3	0	1	0	4	1	1	0	36	0.8	0.8	0	0	0	1.4	0	0.9	0	0	0	1	0	0	0	0	0	0	0
mangalam	3	0	2	1	5	2	1	1	37	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
saraswathy	2	1	2	0	4	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
thangameena	3	1	2	1	5	1	1	1	34	0.9	0.6	0	0	0	1.1	0	0.9	0	0	0	0	0	0	1	0	0	0	0
leelavathy	2	0	3	0	4	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	1	1	0	0
nagamani	2	0	3	1	5	1	1	0	32	0.6	0.7	0	0	0	1.4	0	0.6	0	0	0	0	0	0	0	0	0	0	0
manjula	1	1	1	0	5	2	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
meena	1	1	1	1	4	1	1	1	37	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
vellayamma	2	1	2	1	3	2	2	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
kanniga	2	0	3	1	4	1	1	0	36	0.9	1.1	0	0	0	1.4	0	0.9	0	0	0	1	0	0	0	0	0	1	0
parameshwari	3	0	2	1	5	2	1	0	30	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
kamatchi	3	1	2	1	3	2	1	0	36	0.7	1	0	0	0	1.3	0	0.4	0	0	0	0	0	0	1	0	0	0	0
thulasi	2	1	1	0	4	1	1	0	37	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
parimalam	3	1	1	1	5	2	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
heena	3	1	2	0	4	2	1	0	34	0.6	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
mary	1	1	1	1	4	1	2	0	36	0.7	0.8	0	0	0	1.4	0	0.7	0	0	0	0	0	0	0	0	0	0	0
farsana	2	1	2	0	3	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
usha	3	0	1	1	5	1	1	0	30	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	1	0	0	0	1	0	0	0
uma	2	0	2	1	4	1	1	0	31	0.7	0.6	0	0	0	1.4	0	0.8	0	0	0	0	0	0	0	0	0	0	0
sivapriya	3	1	1	1	3	2	1	0	32	0.4	0.6	0	0	0	1.4	0	0.6	0	0	0	0	0	0	0	0	0	0	0
vilvapriya	3	1	2	1	3	2	1	0	39	0.7	0.8	0	0	0	1.5	0	0.5	0	0	0	0	0	0	1	0	1	1	0
vaishnavi	2	0	1	1	4	1	1	0	35	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	1	0	1	0	0
deepa	2	0	1	1	3	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
karunya	2	1	2	1	4	1	1	0	36	0.7	0.9	0	0	0	1.4	0	0.6	0	0	0	0	0	0	0	0	0	1	0
sumathy	1	0	1	1	4	1	1	0	40	0.8	0.6	0	0	0	1.6	0	0.9	0	0	0	0	0	1	0	0	1	0	0
angeline	3	1	2	0	3	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.5	0	0	0	0	0	0	0	0	0	0	0
apoorva	2	1	1	1	4	1	1	0	36	0.7	0.6	1	0	1	1.4	0	0.7	0	0	1	0	0	0	0	1	0	0	0
noornisha	3	0	2	0	3	1	1	0	36	0.7	0.9	0	0	0	1.1	0	0.9	0	0	0	1	0	0	0	0	0	0	0
inbamatha	2	1	1	1	4	1	1	0	33	0.7	0.6	0	0	0	1.4	0	0.8	0	0	0	0	0	1	0	0	0	0	0
kalaimahal	3	0	1	1	3	1	1	0	34	0.5	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
asha	2	1	3	1	4	1	1	0	36	0.7	0.5	0	0	0	1.4	0	0.7	0	0	0	0	0	0	0	0	0	0	0
sundari	4	0	1	1	4	1	1	0	38	0.7	0.6	0	0	0	1.6	0	0.9	0	0	0	0	0	0	1	0	0	0	0
kamala	2	0	1	0	3	1	1	0	28	0.7	0.6	0	0	0	1.4	0	0.8	0	0	0	0	0	0	0	0	0	0	0
kiran	3	0	3	1	4	1	1	0	36	0.9	0.6	0	0	0	1.2	0	0.9	0	0	0	0	0	0	0	0	0	0	0
leelavathy	2	1	1	1	4	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	0	0	0	0
haripriya	2	1	2	1	3	1	1	0	36	0.7	0.6	0	0	0	1.4	0	0.5	0	0	0	0	0	0	0	0	0	1	0
venda	3	0	1	1	4	1	1	0	35	0.8	0.4	0	0	0	1.3	0	0.9	0	0	0	0	0	0	1	0	0	0	0
thiruchelvi	2	1	2	0	3	1	1	0	39	0.7	0.6	0	0	0	1.1	0	0.9	0	0	0	1	0	0	0	0	0	0	0
akila	3	0	1	1	4	1	1	0	36	0.7	0.6	0	0	0	1	0	0.7	0	0	0	0	0	0	0	0	0	0	0
kayalvizhi	2	1	1	1	4	1	1	0	35	0.5	0.6	0	0	0	1.4	0	0.9	0	0	0	0	0	0	0	1	0	1	0

LIST OF ABBREVIATION

ODFD	-	Operative Delivery for Fetal Distress
PI	-	Pulsatility Index
RI	-	Resistance Index
LN	-	Labour naturale
LSCS	-	Lower Segment Caesarean Section
UAS	-	Uterine Artery Score
BFC	-	Blood Flow Classes
PLS	-	Placental Score
NICU	-	Neonatal Intensive Care Unit
BMI	-	Body Mass Index

CASES -60

CONTROLS -60

AGE

1-<20

2-21 TO 25

3-26 TO 30

4-31 TO 35

5->36

GRAVIDA

1-PRIMI

2-MULTI

BMI

1-<20

2-21 TO 25

3-26 TO 30

4-31 TO 35

5->36

HAEMOGLOBIN

1<10.5

0>10.5

SOCIO ECONOMIC CLASSES

1-CLASS 1

2-CLASS 2

3-CLASS 3

4-CLASS 4

5-CLASS 5

SYSTOLIC BP

1-<140 MMHG

2-140 TO 160 MMHG

3- >160 MMHG

DISTOLIC BP

1- <90 mmhg
2- 90 TO 110 mmhg
3- >110mmhg

PROTEINURIA

1-YES

2-NO

RIGHT UTERINE ARTERY NOTCH

LEFT UTERINE ARTERY NOTCH

1 –YES

2- NO

UTERINE ARTERY SCORES

0, 1, 2, 3, 4

BLOOD FLOW CLASSES

0, 1, 2, 3

PLACENTAL SCORE

0, 1, 2, 3, 4, 5, 6, 7

MCA/UTERINE RATIO & MCA/UMBILICAL RATIO

1- ABNORMAL
0- NORMAL VALUE

MODE OF DELIVERY

1, labour natural

0, lscs

ODFD-OPERATIVE DELIVERY FOR FETAL DISTRESS

1, yes

0, no

OLIGOHYDROMNIOS

1, yes

0, no

NICU ADMISSION

1- yes

0-no

LOW BIRTH WEIGHT

1- yes

0-no

POOR APGAR SCORE

1- yes

0-no

PRETERM BIRTH

1- yes

0-no

PERINATAL MORTALITY

1- yes

0-no